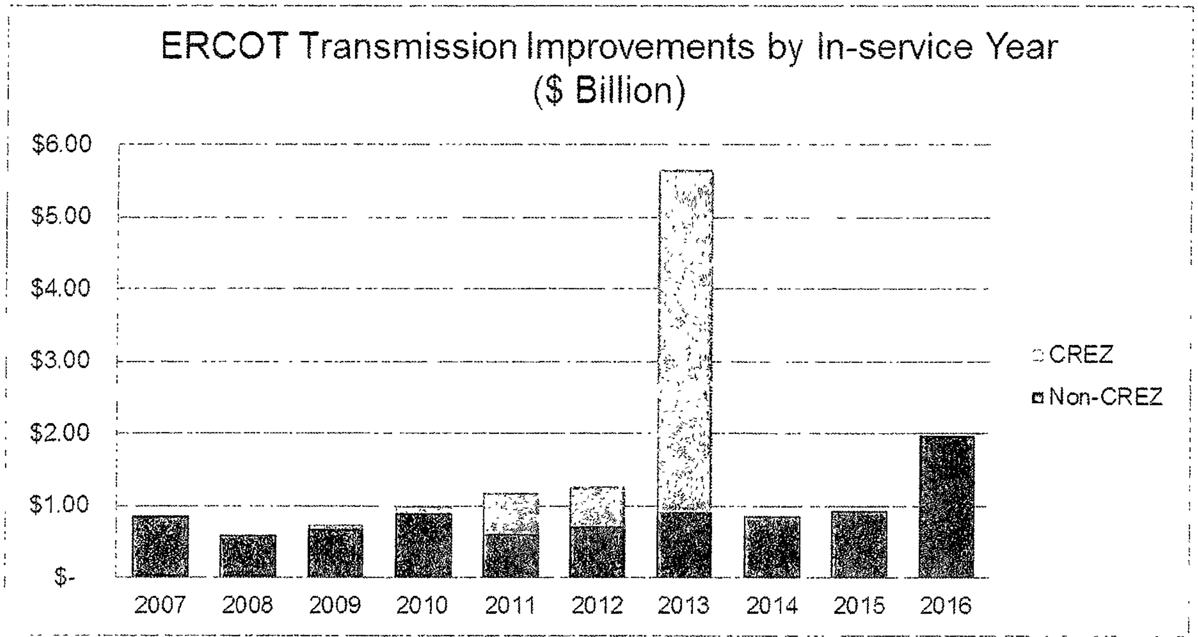

Figure 2.1: Completed ERCOT Transmission Improvements by Year

Transmission improvement projects that are estimated to cost more than $15 million or that require a Certificate of Convenience and Necessity (CCN) are reviewed by the RPG prior to implementation[1]. The RPG is a non-voting forum made up of ERCOT, TSPs, market participants, other stakeholders, and PUCT Staff. In 2017, $890 million of transmission improvement projects were reviewed and endorsed through the RPG process. Figure 2.2 shows the estimated cost of planned transmission projects by in-service year and separated by voltage class.

[1] Per ERCOT Protocol Section 3.11.4 certain projects are exempt from RPG review such as projects to connect new generation or load customers

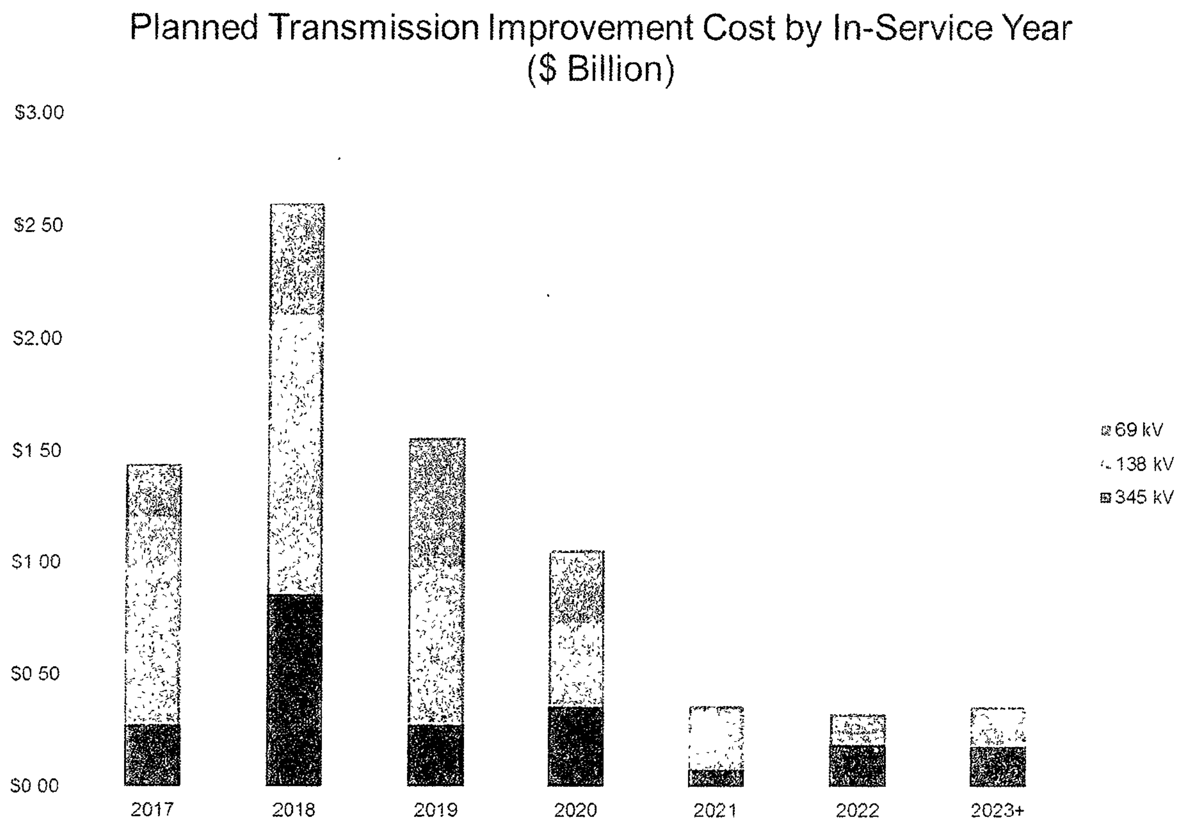

Figure 2.2: Planned Transmission Improvements by Year

A comprehensive list of recently completed and future transmission projects can be found in the Transmission Project Information Tracking (TPIT) report located at: http://www.ercot.com/gridinfo/sysplan/.

Congestion occurs when transmission constraints do not allow for the most efficient dispatch of generation to meet customer demand. Table 3.1 and Figure 3.1 show the top 15 congested constraints on the ERCOT system, from October 2016 through September 2017, based on real-time data.

Table 3.1: 2017 Top 15 Congested Constraints on the ERCOT System

Map Index	Constraint	Congestion Rent
1	North to Houston Import	$174,303,465
2	Panhandle Export Limit	$97,360,991
3	Wagley Robertson-Blue Mound 138 kV Line	$67,453,467
4	Rincon-Whitepoint 138 kV Line	$49,141,886
5	North McAllen-West McAllen 138 kV Line	$48,417,620
6	Carrollton Northwest-Lakepointe 138 kV Line	$25,840,278
7	Wagley Robertson-Summerfield 138 kV Line	$23,046,031
8	Formosa-Lolita 138 kV Line	$18,332,550
9	Azteca-South Edinburg 138 kV Line	$13,608,219
10	North Edinburg 345/138 kV Transformer	$8,193,272
11	Barilla-Fort Stockton 69 kV Line	$7,819,450
12	Rio Hondo-Burns 138 kV Line	$7,616,510
13	Solstice-Pig Creek Tap 138 kV Line	$7,395,231
14	Cibolo-Shertz 138 kV Line	$7,293,679
15	Lynch-Channelview 138 kV Line	$6,846,364

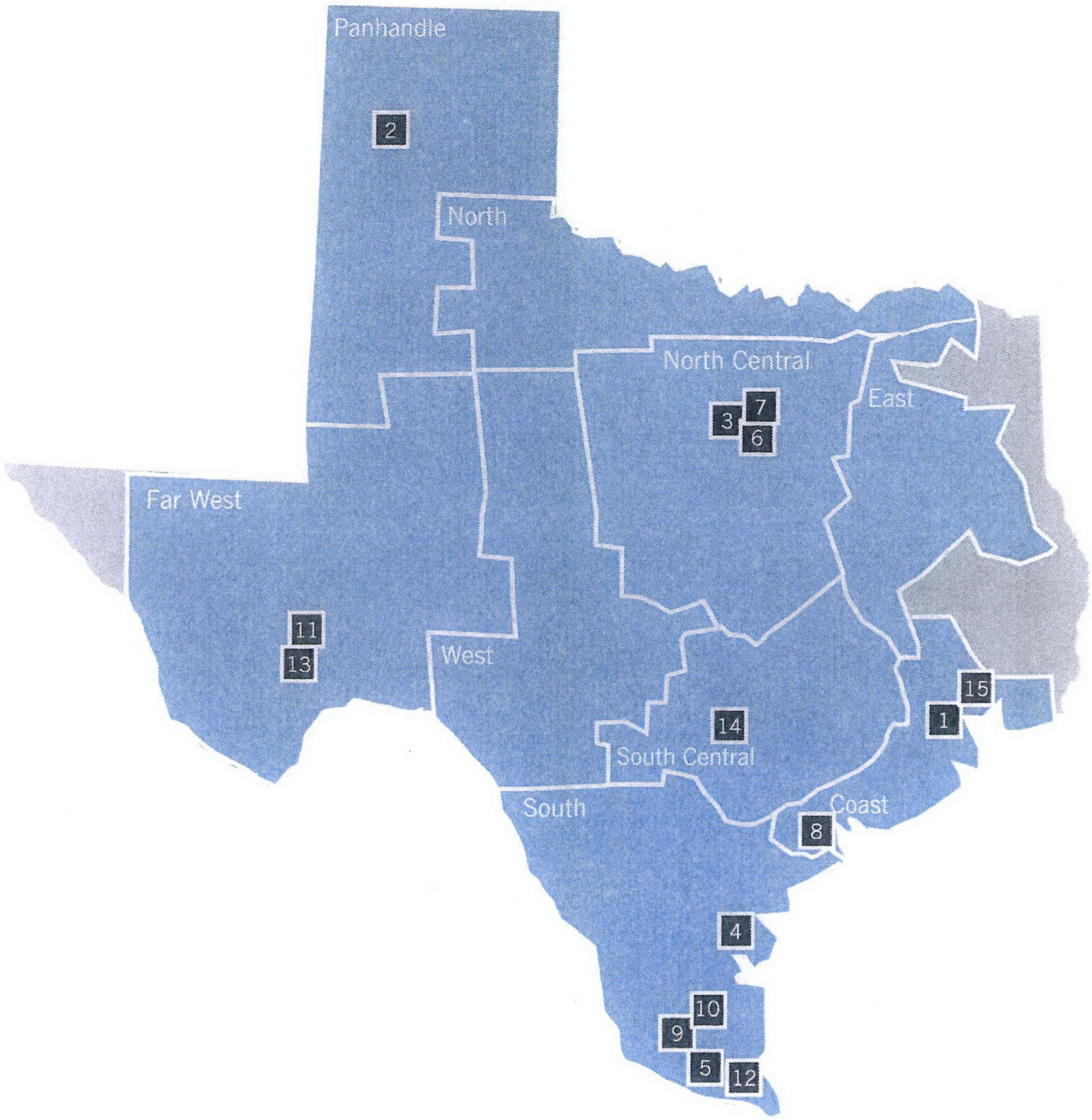

Figure 3.1: Top 15 Congested Constraints

Houston Import

For the third year in a row the import of power into the Houston area from the north caused the highest amount of congestion on the ERCOT system. In 2017, North to Houston Import congestion rent totaled more than $174 million, which is 79% higher than the next highest congested element and more than twice as much as North to Houston Import congestion in 2016. As seen in Figure 3.2, North to Houston Import congestion has been rapidly increasing over the past several years.

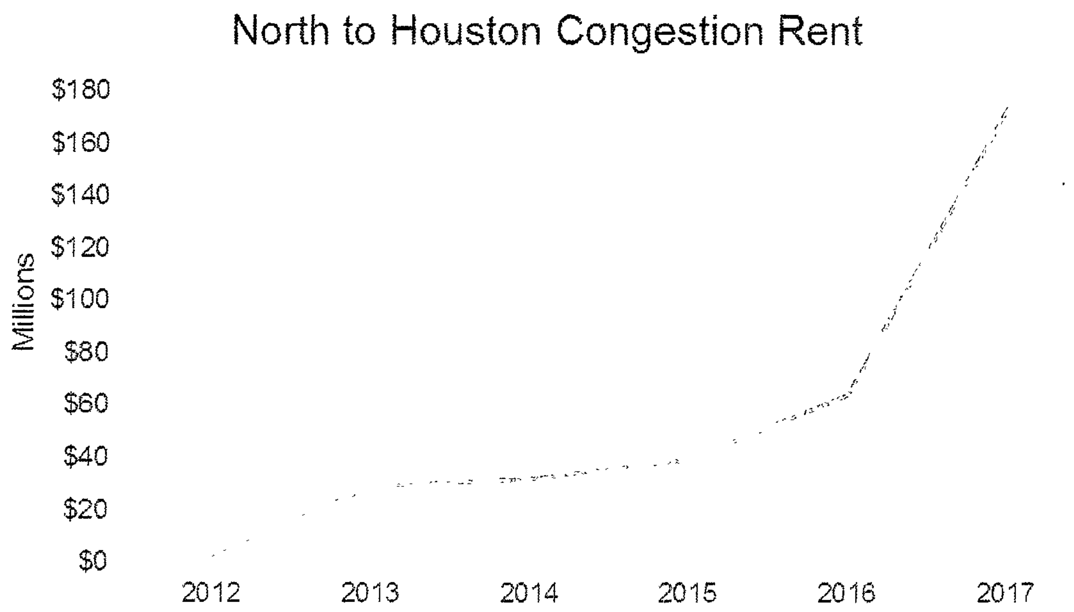

Figure 3.2: North to Houston Congestion Rent by Year

Figure 3.3 shows the 345 kV lines that import power into the Houston area from the north and had significant congestion in 2017.

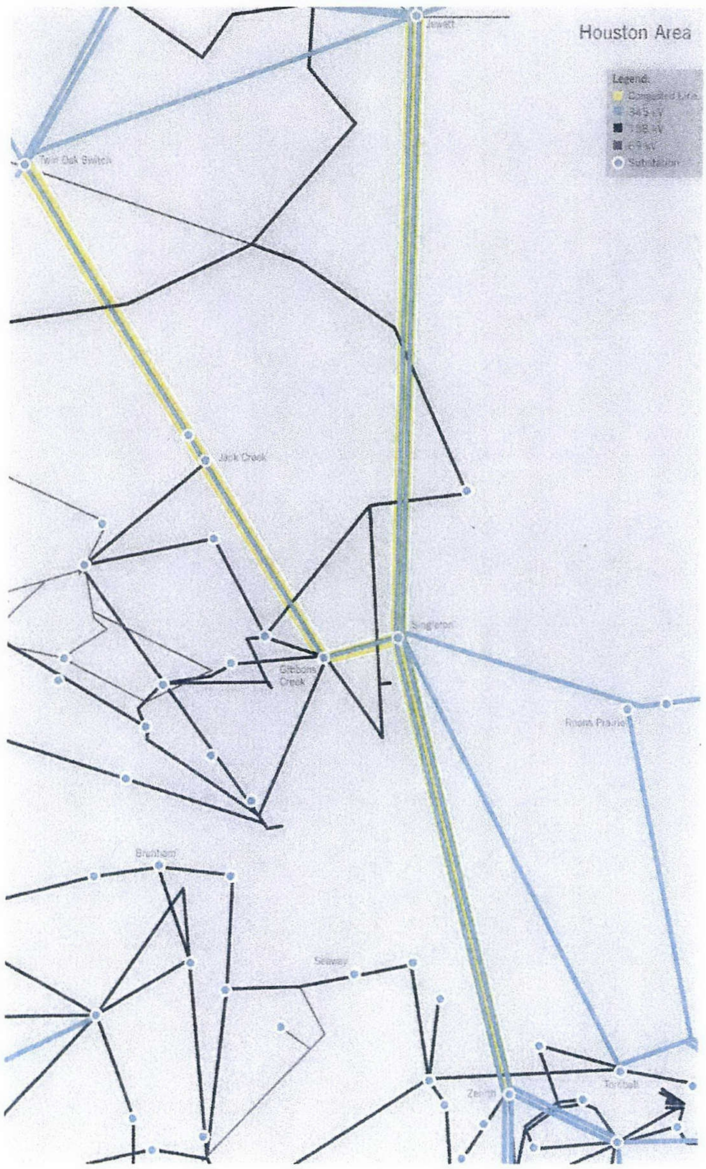

Figure 3.3: Congested North to Houston Import Lines

The customer demand in the Houston metropolitan area is currently served by generation in the area and power imported through 345 kV lines from the north and south. The increase in congestion rent in 2017 is partially due to outages necessary to facilitate the construction of new transmission lines to serve the area. These outages occur when existing transmission lines and substations are taken out of service to allow construction crews to safely install the new equipment. However, much of the congestion can be attributed to the growth in demand and the retiring/ mothballing of generation in the Houston area. The combination of these factors causes increased imports of power from outside of the Houston area. Figure 3.4 shows the peak demand growth for the Coast Weather Zone, which primarily comprises the Houston area.

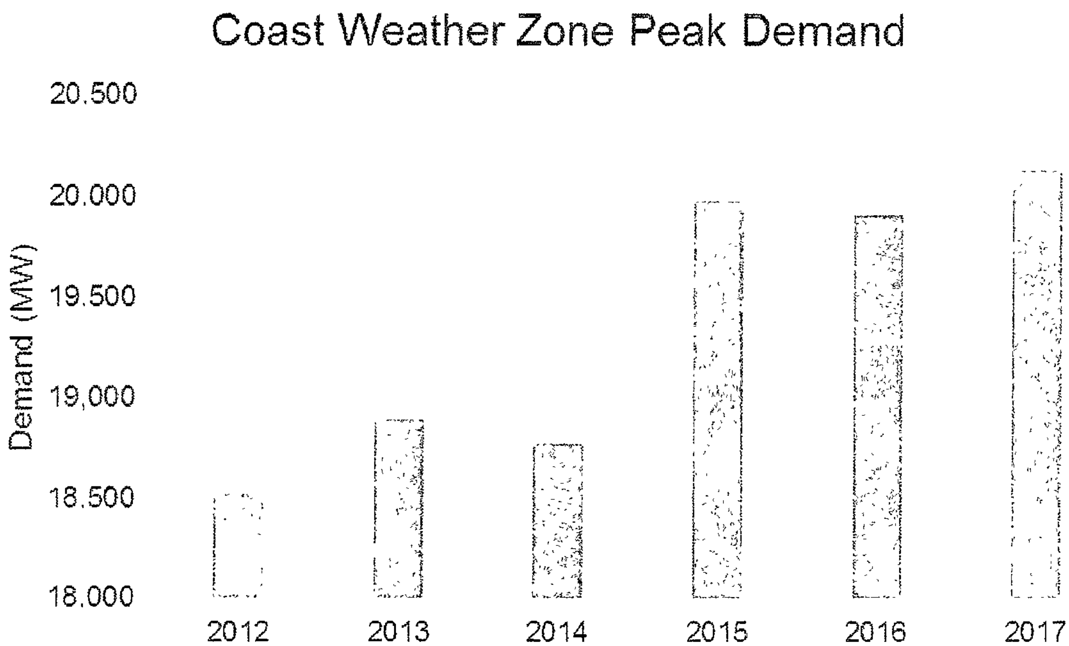

Figure 3.4: Coast Weather Zone Peak Demand by Year

In addition to normal load growth, the Freeport Liquefied Natural Gas (LNG) export facility is expected to come online just south of the Houston area starting in 2018. At nearly 700 MW of peak demand, the Freeport LNG project alone is expected to increase Coast Weather Zone load by 3.5%.

In 2014, the ERCOT Board endorsed the need for the Houston Import Project in order to meet the reliability need to import more power into the area from the north. The project is anticipated to be completed in the spring of 2018. Once completed, the project will increase Houston area reliability and reduce North to Houston Import congestion costs. Figure 3.5 shows the lines associated with the project.

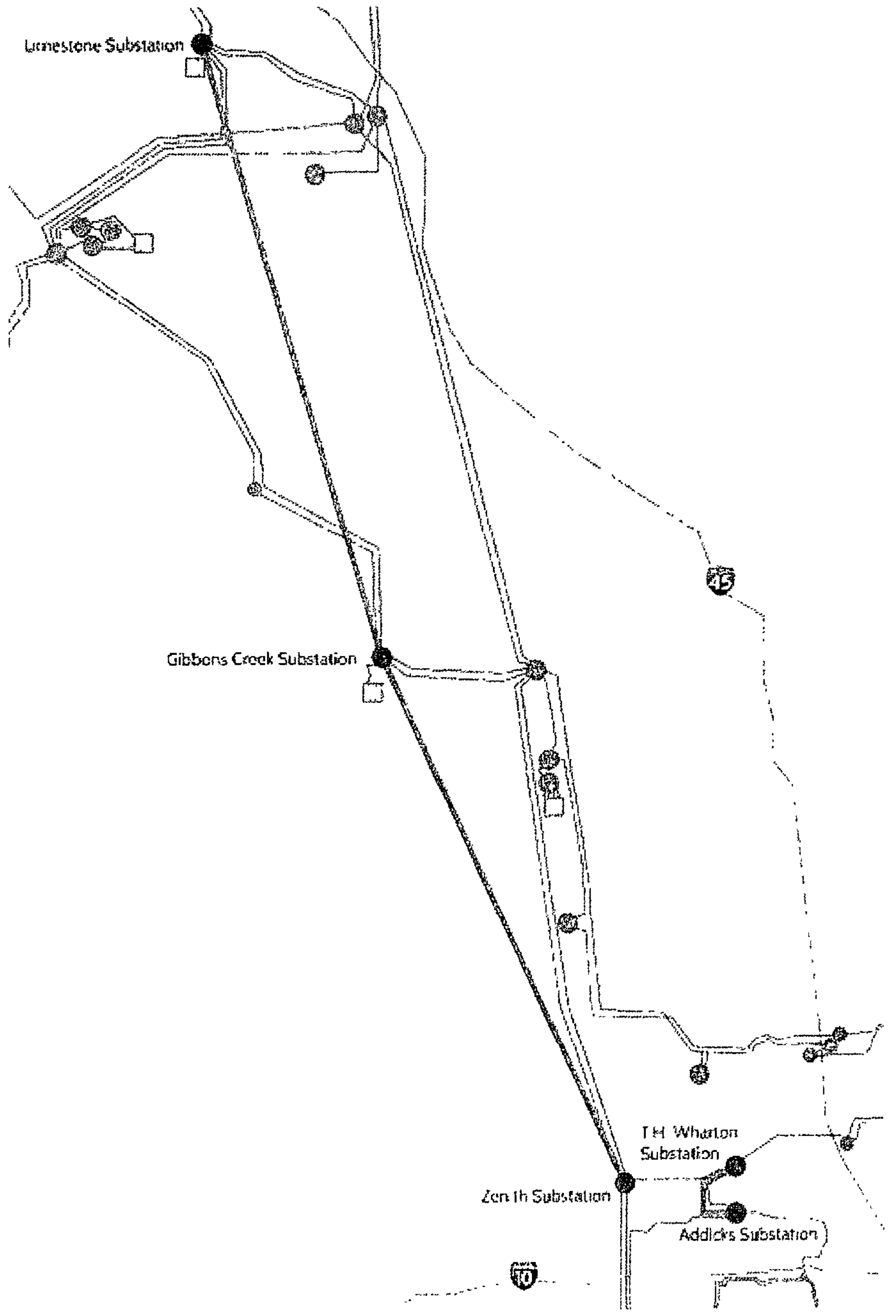

Figure 3.5: Houston Import Project

Panhandle Export

The Panhandle region of the ERCOT grid is a prime location for wind generation development due to the favorable wind regime. In recent years, there has been a significant increase in the amount of new wind generation capacity in the Panhandle, both operating and future plants that are committed to construct.

Due to the power electronic-based design of wind generation and the remote nature of the Panhandle system, dynamic stability and system strength considerations limit the reliable flow of power from the area. As a result, an export limit from the Panhandle region is necessary in order to maintain reliable operation. This export limit is applied to the sum of all power flows across the six circuits that connect the Panhandle region to the rest of the ERCOT system. The Panhandle Export Limit had the second highest amount of congestion on the ERCOT system in 2017, up from being the seventh highest amount in 2016. The amount of Panhandle Export Limit congestion rent experienced in 2017 was more than 50% higher than the highest congested constraint in ERCOT in 2016, the North to Houston Import constraint. Part of the reason for the increase in 2017 was due to the congestion caused by extended maintenance outages taken on Panhandle area transmission.

As of November 2017, 5,536 MW of wind generation capacity in the Panhandle met the requirements for inclusion in the transmission planning models (per Planning Guide Section 6.9). Figure 3.6 shows the planned cumulative in-service capacity by year.

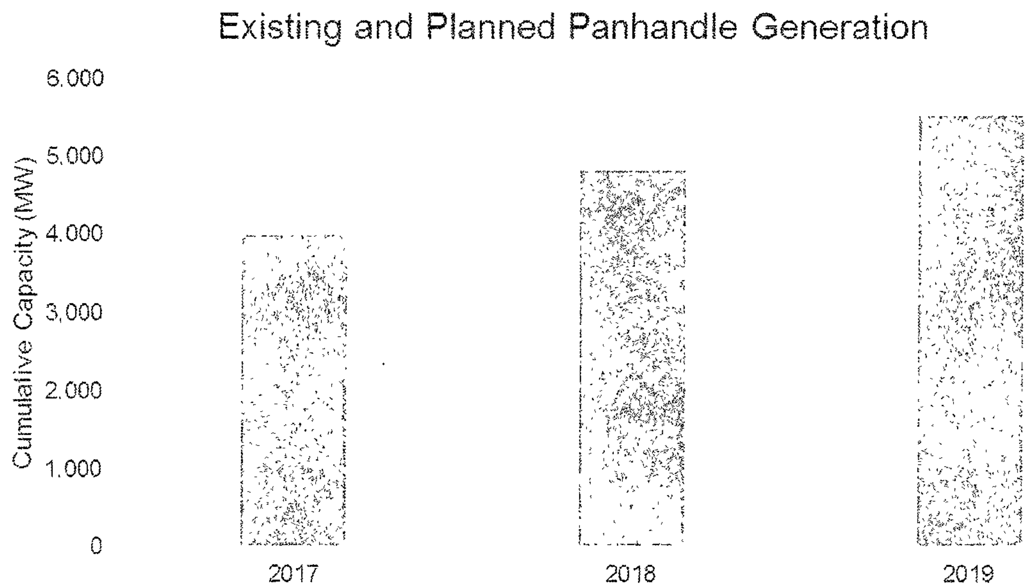

Figure 3.6: Existing and Planned Panhandle Generation

Additionally, as shown in Figure 3.7, approximately 9,600 MW (including wind and solar generation) was under study for future interconnection in the Panhandle. Of that total, 2,768 MW of wind generation capacity in the Panhandle had a signed interconnection agreement but did not satisfy all of the requirements to be included in the transmission planning models.

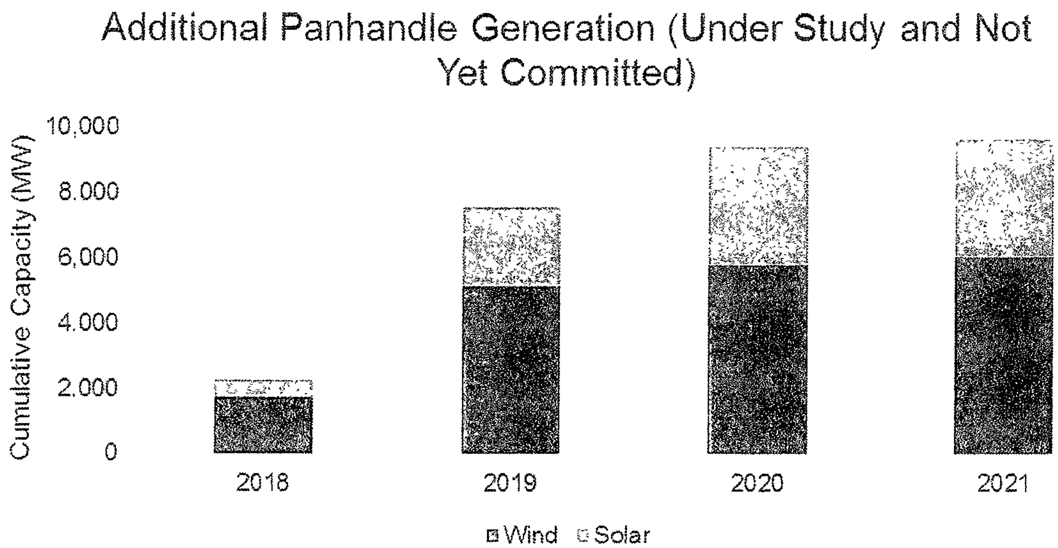

Figure 3.7: Additional Panhandle Generation

As additional generation is constructed in the area, this congestion is expected to increase. Recognizing the existing constraints and projected renewable generation growth in the area, ERCOT continues to evaluate the Panhandle export capability. Two Panhandle transmission improvements are currently underway: (1) synchronous condenser installations at both the Alibates and Tule Canyon substations; and (2) a second 345 kV circuit connecting the Tule Canyon, Ogallala, Windmill, AJ Swope and Alibates substations. Both improvements are expected to be in service in 2018 and will increase the Panhandle generation export capability. However, these projects are not expected to eliminate the congestion in the area. As discussed in Chapter 5, the Panhandle Export Limit is expected to be one of the highest congested constraints over the next six years, and ERCOT and TSPs will continue to evaluate transmission projects to relieve this congestion. Figure 3.8 illustrates the location of the second 345 kV circuit, which is under construction.

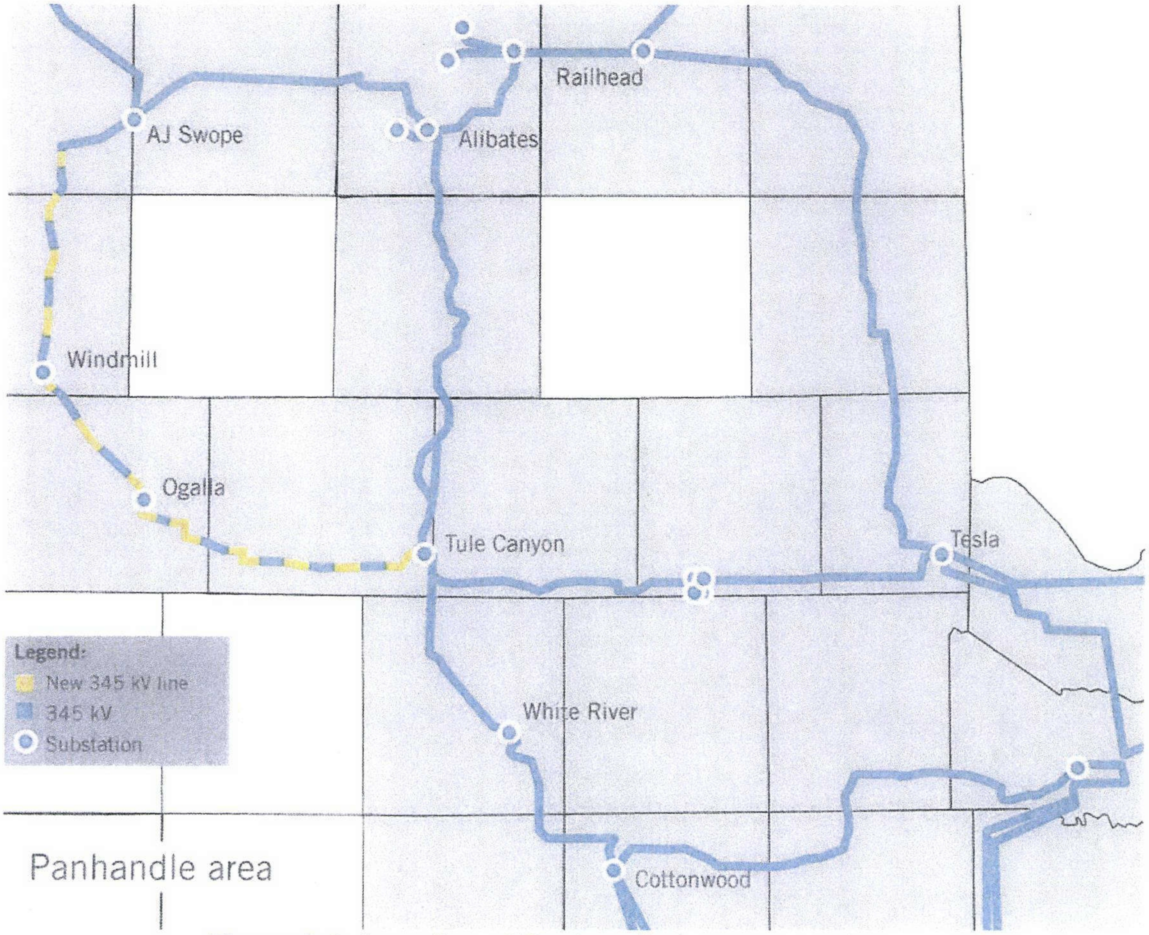

Figure 3.8: Location of Panhandle Improvements

Generic Transmission Constraints

ERCOT uses what are known as Generic Transmission Constraints (GTCs) for the purpose of managing stability, voltage, and other constraints that cannot otherwise be modeled directly in ERCOT's real-time power flow and contingency analysis applications. Recently, ERCOT has seen an increase in the number of GTCs and the congestion caused by GTCs. The Panhandle Export Limit was the highest congested GTC on the ERCOT system in 2017 and the North to Houston GTC contributed to the overall North to Houston Import congestion. Figure 3.9 shows the active, newly identified, and retired GTCs since 2010.

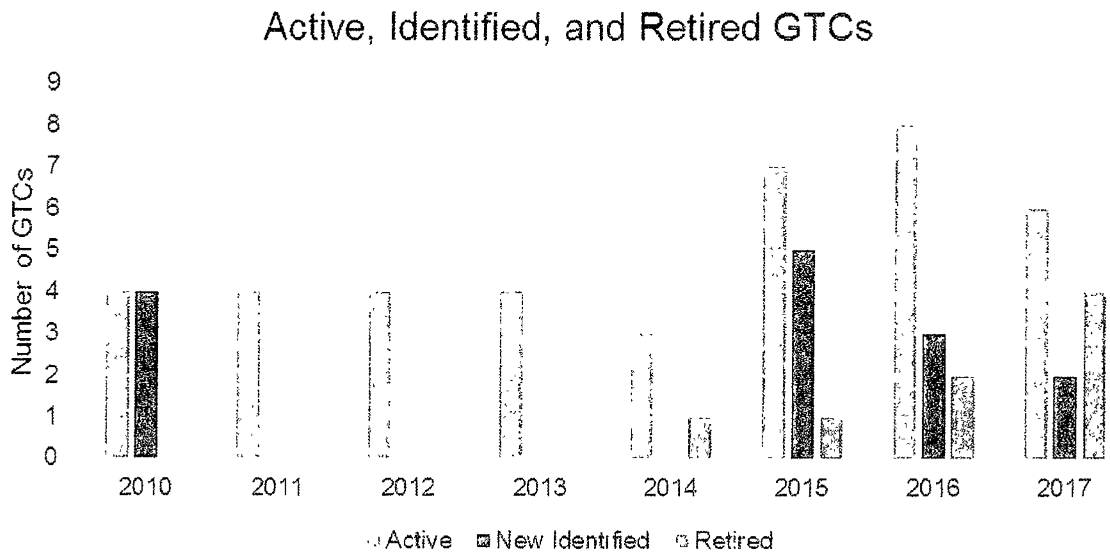

Figure 3.9: Active, Identified, and Retired GTCs

Since 2010, a total of 14 GTCs were created due to stability constraints, and 10 of those have been created in the past three years. The new GTCs created in the past three years were mostly related to inverter-based generation projects (wind and solar) that, similar to the reliability concerns in the Panhandle, were limited by dynamic stability and system strength considerations.

ERCOT has retired eight GTCs based on system enhancement, generator controller adjustment, and generation connectivity changes. As of October 2017, there were six GTCs being utilized to maintain reliability on the ERCOT system.

Due to the increasing number of GTCs identified in recent years, two ERCOT Protocol revisions were approved in 2017 to improve ERCOT processes. First, ERCOT now performs a quarterly stability assessment to determine if a GTC is necessary for any new generator connecting to the ERCOT system in the upcoming quarter. Second, going forward, ERCOT will identify alternatives for GTCs within 180 days after the effective date of a new GTC. These process improvements will ensure that newly interconnected generators can operate reliably, and that ERCOT will actively pursue reliability improvements to minimize the need for GTCs, which can be challenging for system operators.

Outage Related Congestion

When transmission or generation equipment is taken out of service for maintenance, improvement, or due to equipment failure, congestion can result. Much of the congestion experienced on the ERCOT system from October 2016 through September 2017 was caused by such outage conditions.

In addition to outages contributing to the top two constraints, North to Houston Import and Panhandle Export Limit, the seventh highest amount of congestion on the ERCOT system was primarily driven by outages in the Tarrant County area. Specifically, the upgrade of the Eagle Mountain-Wagley Robertson-Saginaw 138 kV line resulted in outages that contributed to the congestion experienced on the Wagley Robertson-Summerfield 138 kV line. This upgrade was completed in the summer of 2017.

The nearby Wagley Robertson-Blue Mound 138 kV line congestion was not caused by outages but rather by high wind and high load conditions. ERCOT recommended upgrading this line in the 2017 RTP. In addition to this upgrade, the 2017 RTP also identified the need for a reconfiguration of the 138 kV lines from Hicks Switch to Alliance to Roanoke. Both of these projects will help mitigate congestion in this area; however, the Hicks Switch area upgrades are not anticipated to be completed prior to 2022.

The other area that experienced a significant amount of outage related congestion was the Lower Rio Grande Valley. Congestion experienced on the North McAllen-West McAllen 138 kV line, Azteca-South Edinburg 138 kV line, and North Edinburg 345/138 kV transformer, can be linked to outages on generation at North Edinburg and McAllen area transmission system improvements. The Hidalgo-Starr Transmission Project, which was endorsed by the ERCOT Board in June 2016 and is planned to go in service by 2020, is expected to help relieve congestion in the area when there are outages.

Currently, there are $6.1 billion of future transmission improvement projects that are expected to be put in service between 2018 and the end of 2023. Table 4.1 and Figure 4.1 show some of the significant improvements planned for completion within the next six years.

Table 4.1: Planned Transmission Improvement Projects

Map Index	Transmission Improvement	In-Service Year
1	Houston Import Project	2018
2	Add second Hicks 345/138 kV Transformer	2018
3	Add fourth PH Robinson 345/138 kV Transformer	2018
4	Add Alibates-Windmill-Tule Canyon 345 kV Line Second Circuit	2018
5	Add Synchronous Condensers at Alibates and Tule Canyon	2018
6	Add Static Var Compensators at LaPalma and Pharr	2018
7	Replace Lon Hill 345/138 kV Transformers	2019
8	New Zorn-Marion 345 kV Line	2019
9	Add second Marion 345/138 kV Transformer	2019
10	New Stewart Road 345 kV Station with 345/138 kV Transformer	2019
11	Add second Sargent Road 345/138 kV Transformer	2020
12	New Riverton-Odessa EHV 345 kV Line	2020
13	Add second Hutto 345/138 kV Transformer	2022
14	New Solstice-Bakersfield 345 kV Line	2022
15	Add second LaPalma 345/138 kV Transformer	2023

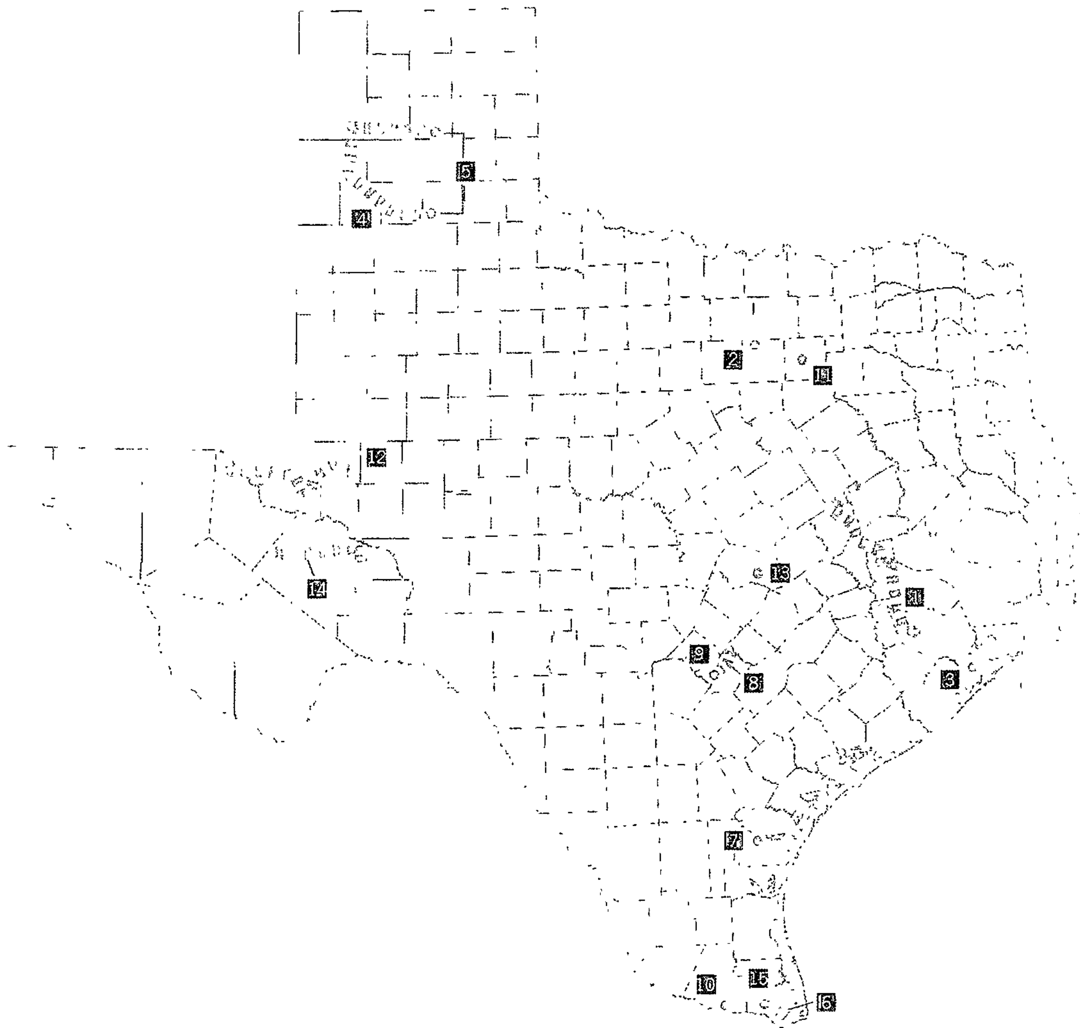

Figure 4.1: Planned Transmission Improvement Projects

In 2012, eight of the top 15 congested transmission elements in ERCOT were in West Texas. With a number of transmission additions and upgrades over the past five years, the amount of congestion in West Texas dropped to two of the top 15 congested transmission elements in 2017. However, the need to expand transmission facilities in West Texas continues due to the load increase related to the oil and natural gas industry and increase in solar generation development. Figure 4.2 shows the Permian Basin oil and natural gas rig count information by county as of November 2017.

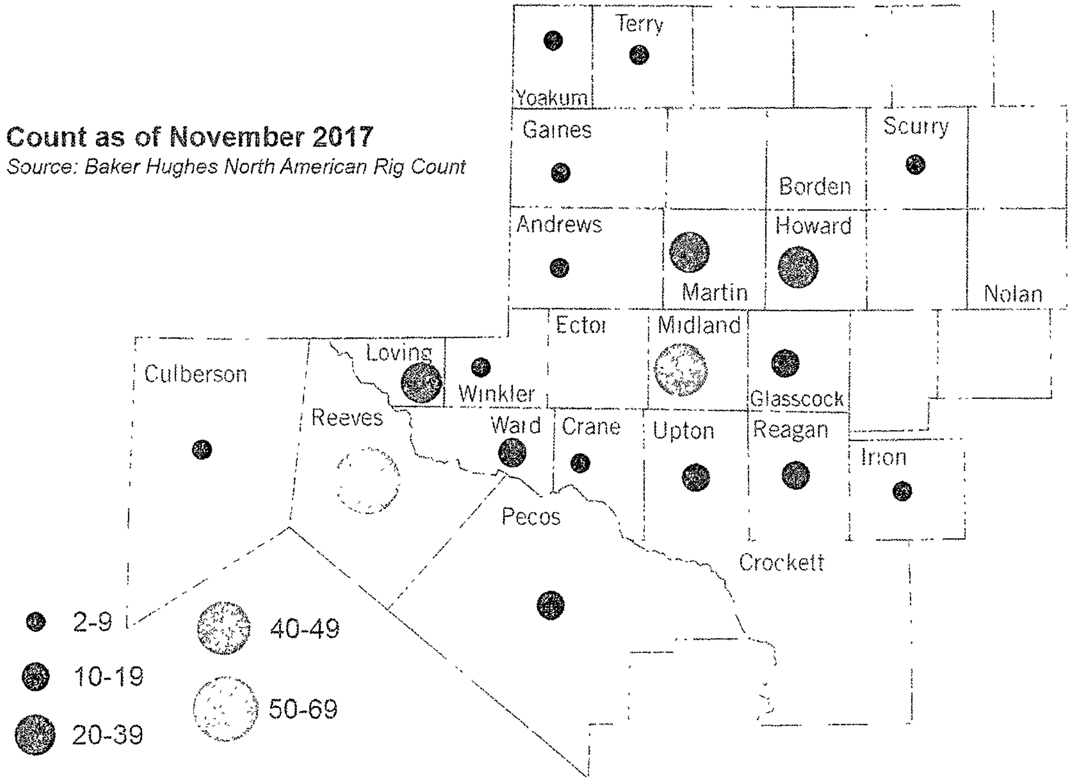

Figure 4.2: Permian Basin Oil and Natural Gas Rig Count

In addition to oil and natural gas production activity in the Permian Basin area, the secondary facilities that support production (including midstream processing plants) have added to the significant load increases in the area. Figure 4.3 shows the Far West Weather Zone historical growth in peak demand from 2009 through 2017. These increases equate to an average annual rate of 8.3% over this time. This amount of load growth (as a percentage) exceeds that of the other weather zones in ERCOT and significantly exceeds the systemwide load growth of 1.6% per year observed during this same time period.

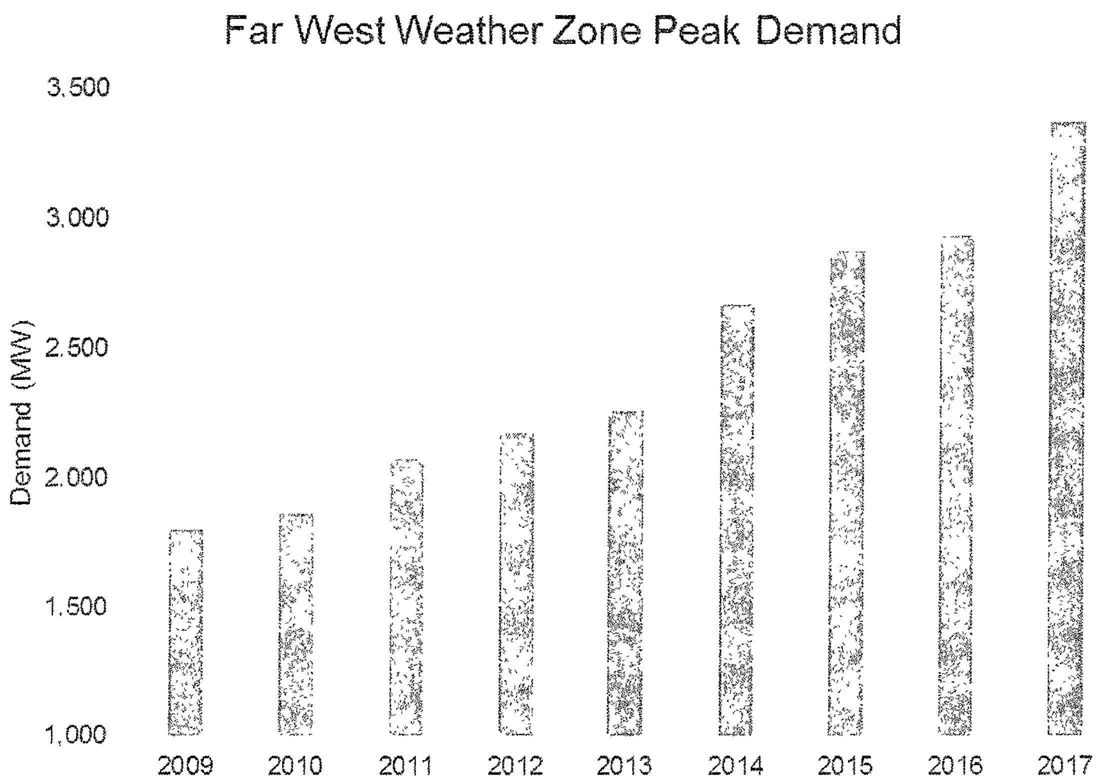

Figure 4.3: Far West Weather Zone Peak Demand by Year

The TSPs in the area, including Oncor, Texas New Mexico Power (TNMP), and American Electric Power Service Corporation (AEPSC), have also identified high load growth rates for concentrated areas of West Texas. Oncor has projected annual load growth rates ranging as high as 11% over the next five years within a portion of the Far West Weather Zone, including Culberson, Reeves, Loving, Ward and Winkler Counties based on committed customer load requests.

The area southwest of Odessa, served by the 69 kV and 138 kV lines between the Permian Basin, Barilla Junction, Fort Stockton Plant, and Rio Pecos stations has seen increased load growth along with solar generation development. There are more than 1,600 MW of solar resources that meet the conditions for inclusion in the transmission planning models and that are expected to come online in Pecos and Upton Counties between 2017 and 2021. AEPSC has projected that the area load will grow to more than 500 MW by 2021.

In June 2017, the ERCOT Board endorsed the Far West Transmission Project to meet the reliability needs in these areas. The project will add over 150 miles of new 345 kV transmission facilities. It will also provide the infrastructure for several transmission expansion options to meet future load and generation growth needs in these areas.

Table 4.2 lists all of the major Permian Basin-related projects evaluated and endorsed by ERCOT and the RPG in 2016 and 2017. Figure 4.4 shows a map of these projects.

Table 4.2: Major 2016 and 2017 RPG Permian Basin Projects

Map Index	Transmission Improvement	Cost Estimate
1	Barilla Junction Area Improvement Project	$77.0 million
2	Line 69H Rebuild and 138 kV Conversion Project	$50.6 million
3	Riverton-Sand Lake Project	$40.2 million
4	Andrews County South – Holt – Andrews North Upgrade Project	$33.5 million
5	Katz to Tardis Transmission Project	$30.5 million
6	Salt Creek Project	$26.0 million
7	Far West Texas Project	$336.0 million

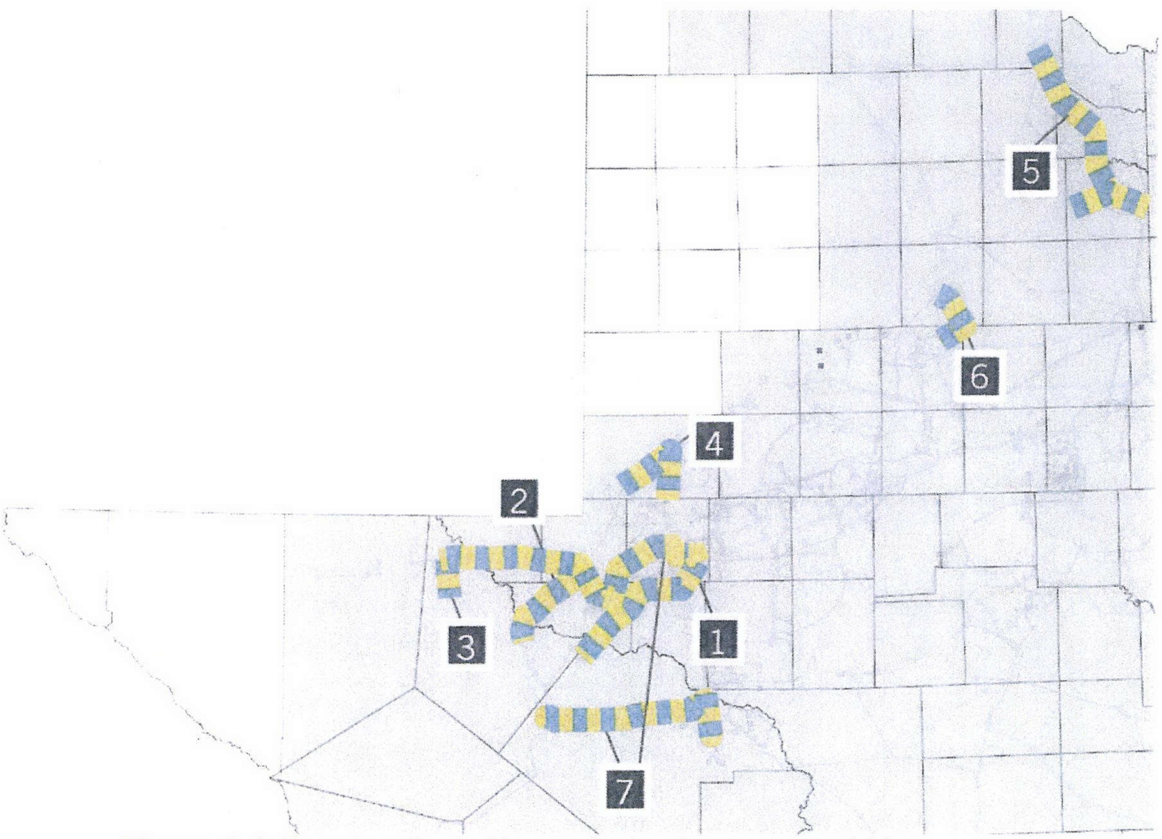

Figure 4.4: Permian Basin Transmission Improvement Map

Freeport Area

The Freeport area located in Brazoria County, adjacent to the Gulf of Mexico, is a highly industrialized region and has several large chemical facilities served by the CenterPoint Energy transmission system.

Since 2012 CenterPoint Energy has proposed various transmission upgrade projects in the Freeport area to accommodate large load additions (including the Freeport Area Upgrades and the Dow-Velasco 345/138 kV Autotransformer Addition projects). In 2014, the ERCOT Board endorsed the Jones Creek Project to serve an additional 700 MW of load associated with the proposed natural gas liquefaction and export facility being developed by Freeport LNG. The Jones Creek Project consists of a new 345/138 kV CenterPoint Energy substation in the Freeport Area with two 345/138 kV autotransformers and reconfiguration of circuits such that two 345 kV and four 138 kV lines terminate into the new Jones Creek substation.

In early 2017, CenterPoint indicated that it had signed agreements with several industrial customers (including Dow Chemical Company) for additional load in the Freeport area. A total of 1,340 MW of additional demand is projected to be in-service between 2019 and 2022. Figure 4.5 shows the historical and projected load growth in the Freeport area.

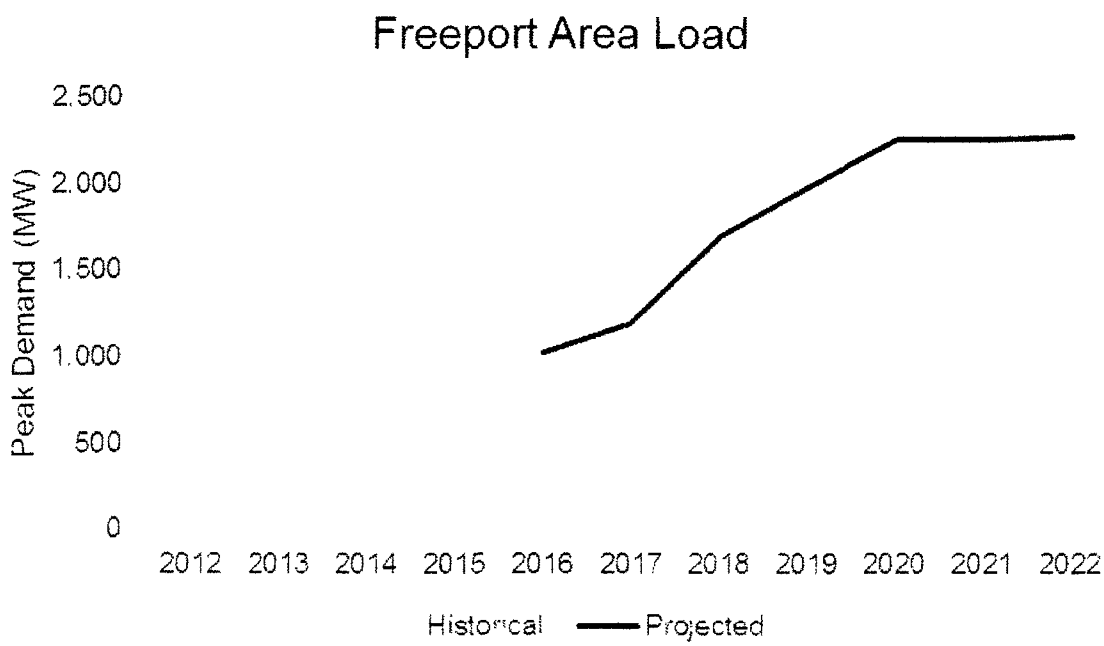

Figure 4.5: Historical and Projected Load Growth in the Freeport Area

In May 2017, CenterPoint Energy submitted the Freeport Master Plan Project to the RPG to address the reliability needs in the Freeport region. The project is proposed to be completed in two phases – 2019 and 2022. The initial phase, called the 'Bridge the Gap Upgrades,' consists of a 345 kV line reconfiguration, a 345/138 kV transformer addition, and new reactive devices and is estimated to cost $32.3 million. The second phase includes a new Bailey to Jones Creek 345 kV double circuit transmission line and is estimated to cost $214.4 million. In December 2017, the ERCOT Board endorsed the need for this project. Figure 4.6 shows the location of the new Bailey to Jones Creek 345 kV line.

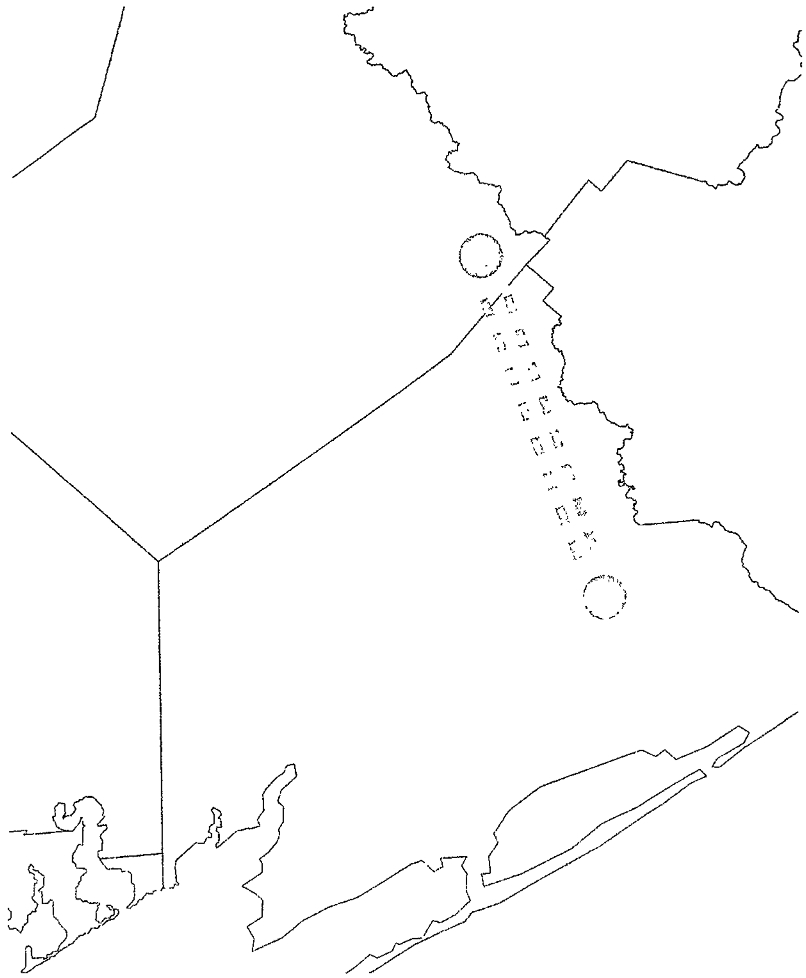

Figure 4.6: Bailey to Jones Creek 345 kV Transmission Line Project

Continued customer demand growth throughout the state is a key driver of the need for transmission improvements in the ERCOT region. The recently completed 2017 Regional Transmission Plan (RTP) identified 60 transmission projects needed to satisfy the reliability planning criteria in the 2019 to 2023 timeframe, 22 of which were identified in prior planning studies. The projects included approximately 190 miles of transmission upgrades and 140 miles of new circuits. Figures 4.7 and 4.8 show the number of transmission improvements identified in the RTP by weather zone and type (note a project may contain multiple improvements). More information on these projects can be found in the 2017 RTP report posted on the ERCOT Market Information System website.

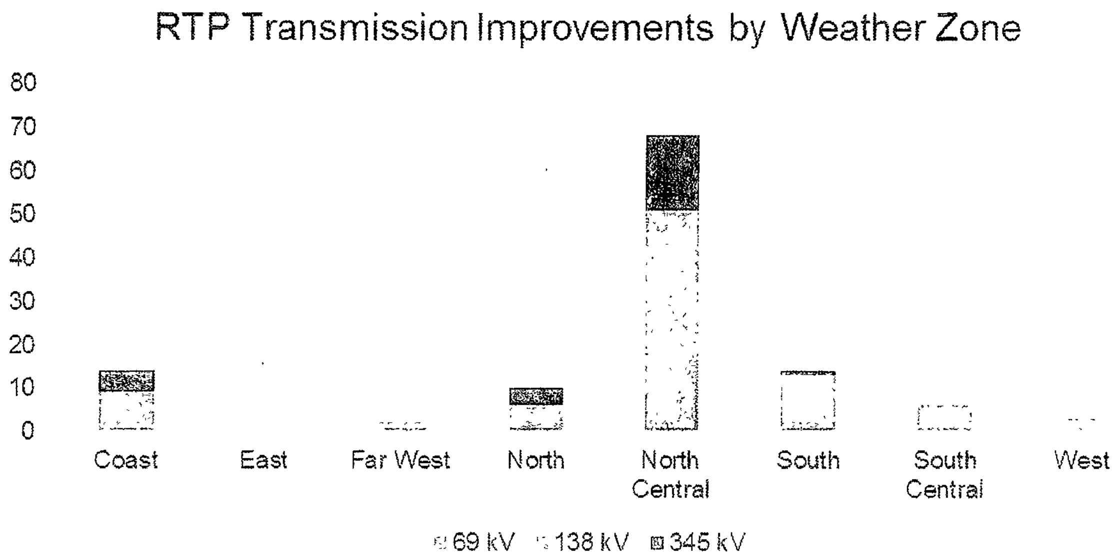

Figure 4.7: RTP Transmission Improvements by Weather Zone

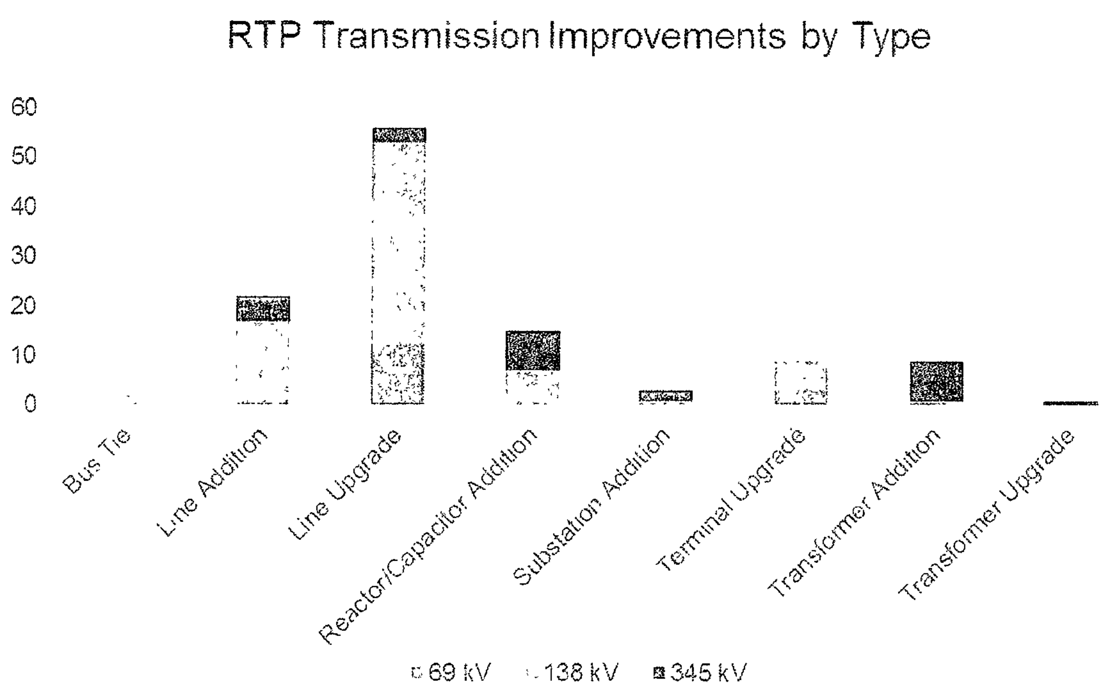

Figure 4.8: RTP Transmission Improvements by Type

Transmission is used to transport power from generators to consumers. Thus, transmission system improvements are needed when demand from consumers grows or when the generation that serves consumers changes. Recently, ERCOT has observed a change in the generation that serves consumers, both in the retirements of legacy generators and in the addition of new generation.

When a generator owner decides to retire or mothball a plant they must submit a Notice of Suspension of Operations (NSO) to ERCOT. In the 12-month period from November 2016 through October 2017, ERCOT received NSOs for 4,787 MW of capacity in which an owner was requesting to permanently retire a generator. Figure 5.1 shows the capacity of generation retirements for this time period by fuel type.

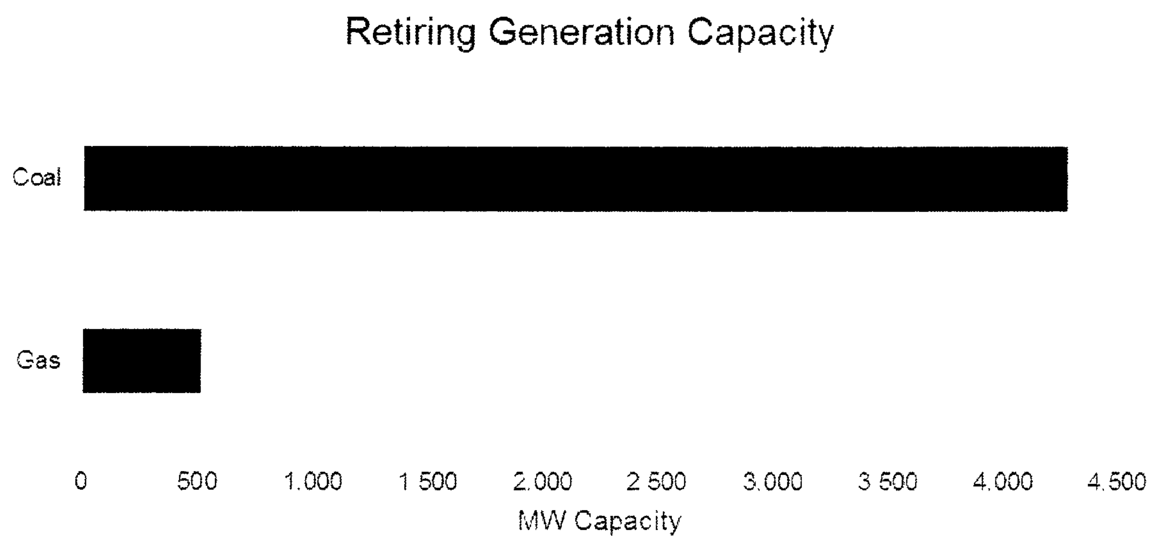

Figure 5.1: Retiring Generation Capacity

While some of the plants are scheduled to retire in early 2018, this amount of generation would represent one of the largest amounts of generation capacity to retire within a year. Figure 5.2 shows the top five historic years in ERCOT between 1999 and 2016 in terms of capacity of generators retiring.

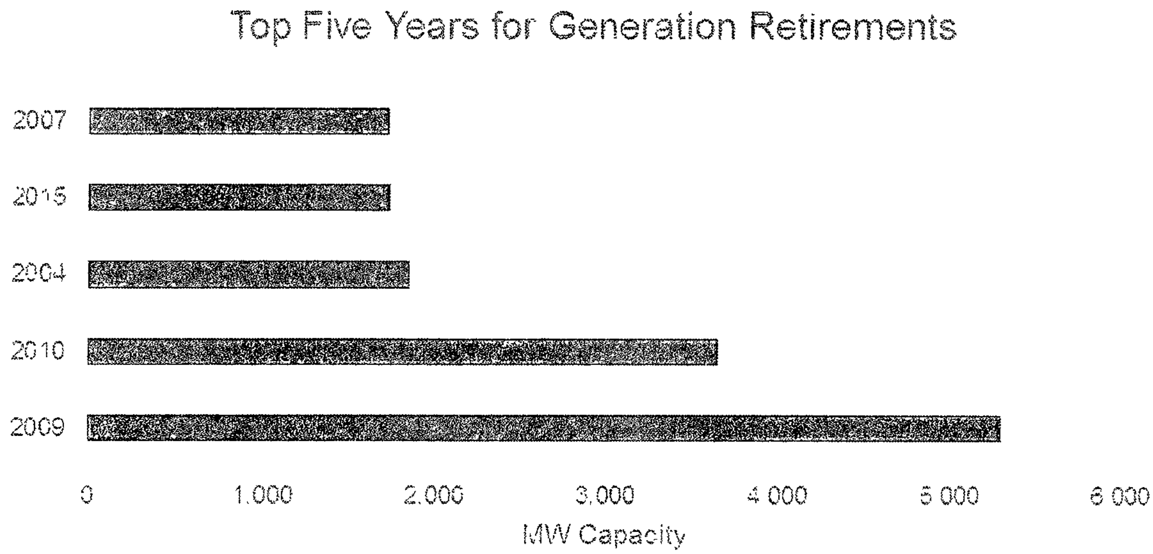

Figure 5.2: Top Five Years for Generation Retirements

During that same time period (November 2016 through October 2017), ERCOT has added 5,356 MW of new generation capacity. More than half of this capacity is from wind and solar plants; the remainder is from new gas generation plants. Figure 5.3 shows the generation capacity additions by fuel type for this time period.

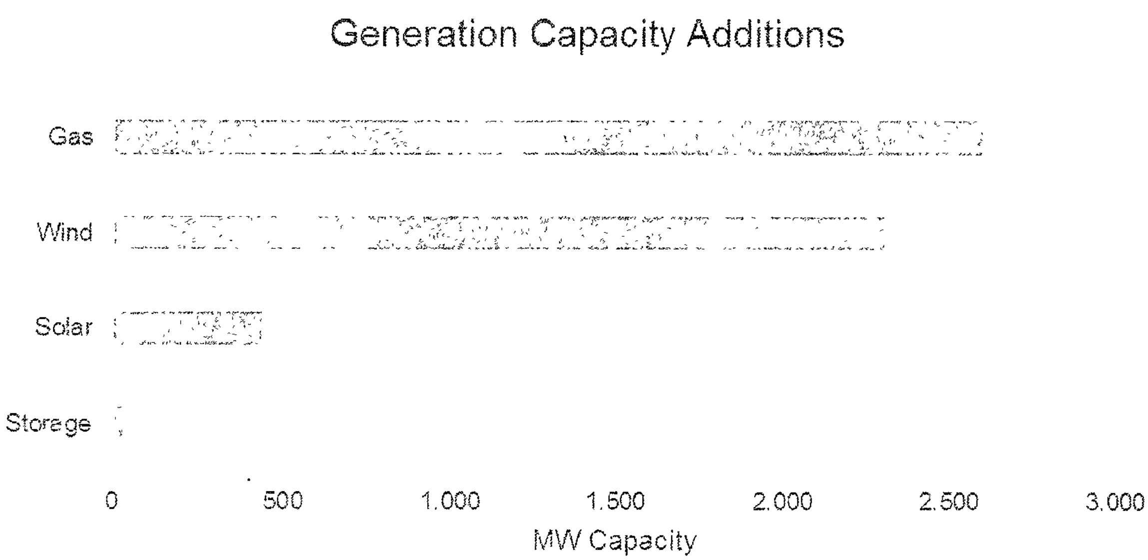

Figure 5.3: Generation Capacity Additions (November 2016-October 2017) by Fuel Type

Looking ahead, ERCOT has observed a record amount of generation interconnection study activity in 2017. From the beginning of 2017 through November, ERCOT has received 183 generation interconnection requests. This is far more than any other year, as the most requests received in any previous year was 108 in 2013. Figure 5.4 shows the number of generation interconnection requests by year for the past nine years.

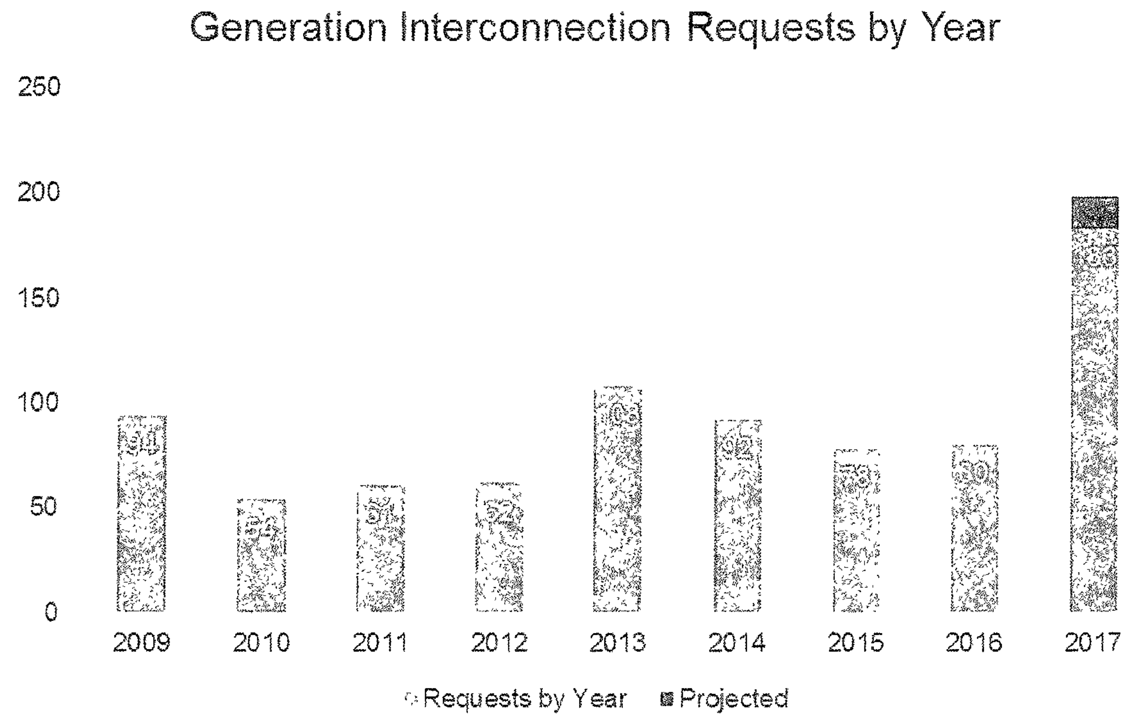

Figure 5.4: Generation Interconnection Requests by Year

As shown in Figures 5.5 and 5.6, the majority of the generation interconnection requests received in 2017 are for utility-scale solar plants.

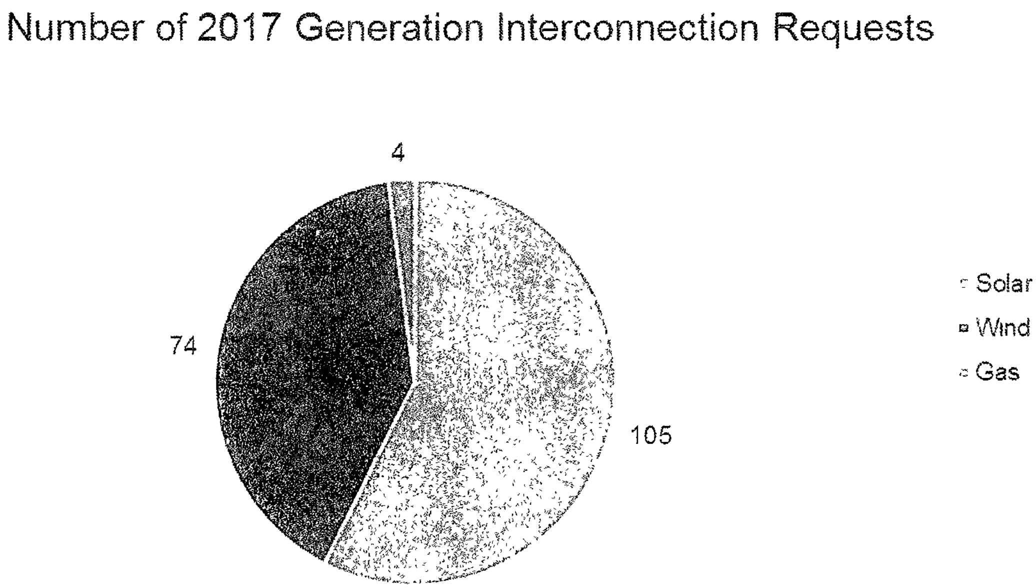

Figure 5.5: Generation Interconnection Requests

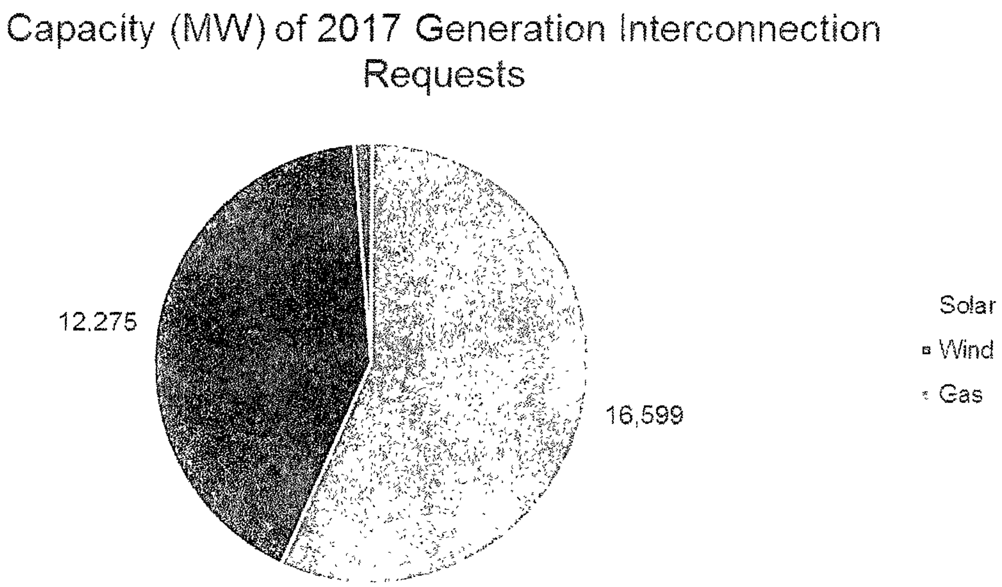

Figure 5.6: Generation Interconnection Requests

Including the generation interconnection requests from previous years, in total there were approximately 24,700 MW of solar generation projects under study in ERCOT as of November 2017. Approximately 966 MW of these solar projects in the study queue have interconnection agreements (IA) with posted financial security and are projected to be in service by the end of 2018.

Figure 5.7 shows the breakdown of the proposed solar generation in the study process by weather zone. As shown, many of the proposed solar projects are located in the Far West Weather Zone, specifically in Pecos and Upton Counties.

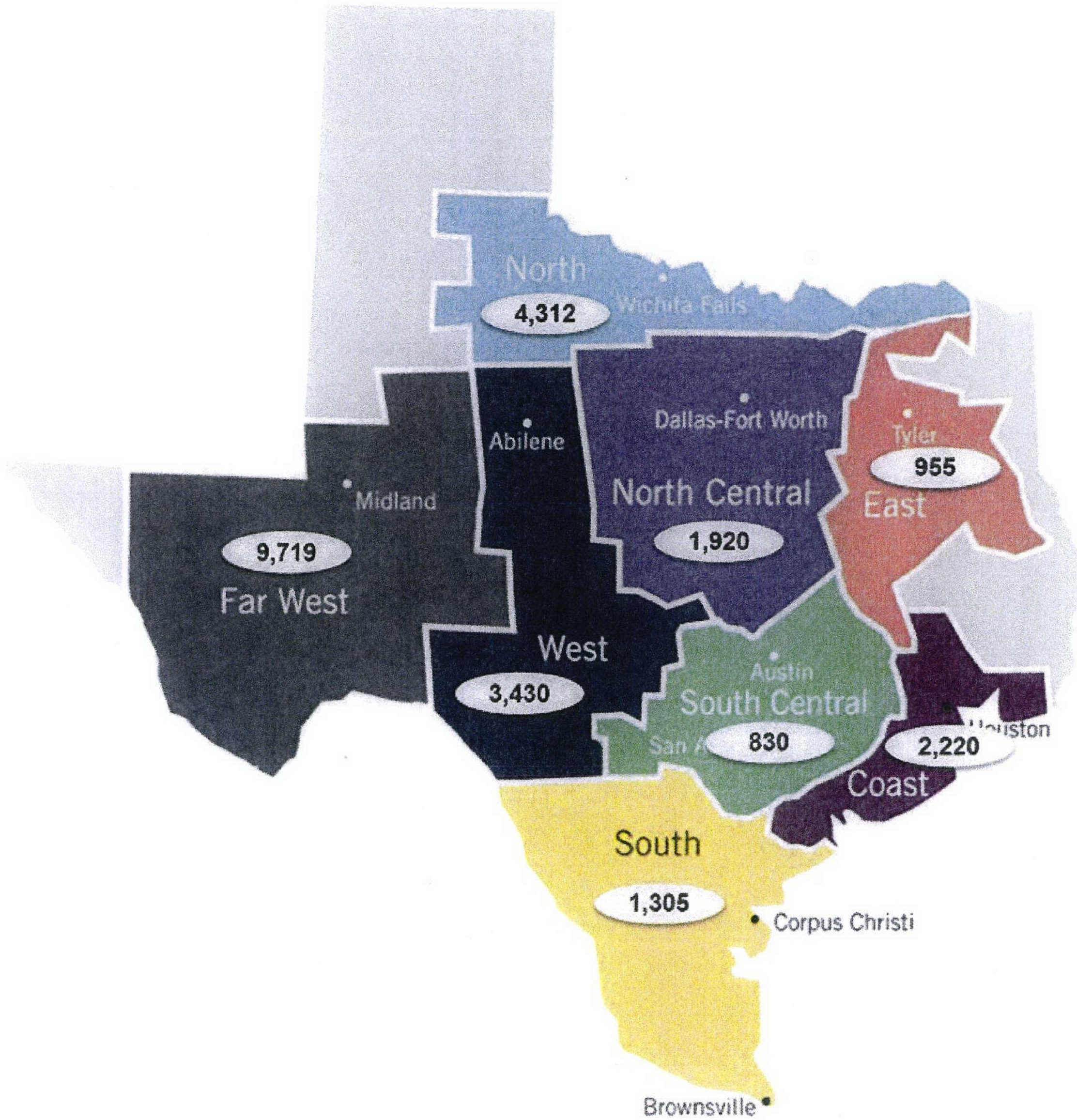

Figure 5.7: Proposed Solar Generation in the Study Process by Weather Zone

The trend of legacy fossil fuel plants retiring and new renewable generation plants being brought online is consistent with the results of the 2016 Long-Term System Assessment (LTSA). One of the key findings of the LTSA was that all scenarios showed a significant amount of solar additions and the retirement of coal- and natural gas-fired generation. The LTSA results showed an increase of between 14,500 MW and 28,100 MW of solar generation capacity, depending on the scenario. The 2016 LTSA also concluded that this change in the generation mix would drive the need for additional transmission system improvements to move the power from sunnier West Texas to the load centers in the eastern part of the state.

As previously mentioned, in 2017 ERCOT received NSOs for 4,787 MW of capacity in which an owner was requesting to permanently retire a generator. When ERCOT receives an NSO, it is required to perform an analysis to determine if the retiring generator is required to maintain transmission system reliability. While none of the generators requesting to retire were needed to maintain local transmission system reliability, the absence of these generators could cause or exacerbate congestion on the ERCOT system. Table 5.1 contains a list of these potential constraints for 2018.

Table 5.1: List of Potential Constraints Due to Generation Retirements

Index	Transmission Improvement
1	Wagley Robertson-Blue Mound 138 kV Line
2	Coleto Creek-Kenedy 138 kV Line
3	Payne-Van Alystne 138 kV Line
4	Firewheel-Wylie 138 kV Line
5	Rice-Corsicana 69 kV Line
6	Forney-Forney West 138 kV Line
7	Forest Grove-Eustace 138 kV Line
8	Eustace 138/69 kV Transformer
9	Eustace-Pauline 138 kV Line
10	Glidden 138/69 kV Transformer

Future year constraints are also analyzed as part of the annual Regional Transmission Plan (RTP). Projects are identified to resolve the constraints expected to cause the most congestion on the system. If a project meets the economic planning criteria by reducing overall system costs, it is included in the recommended project set. Often, however, the annualized capital cost of the project is greater than the expected systemwide production cost savings. When this occurs, the project will not be constructed and the congestion will persist. Table 5.2 and Figure 5.8 show the constraints projected to be the most congested for 2020 and 2023 based on production-cost simulation modeling conducted as part of the 2017 RTP.

Table 5.2: List of Projected Constraints (2020, 2023)

Map Index	Projected Constraining Element	2020 Congestion	2023 Congestion
1	South Texas Project-Jones Creek 345 kV Line		
2	Panhandle Export Limit		
3	Cico-Comfort 138 kV Line		
4	Kendall-Bergheim 345 kV Line		
5	Jack Creek-Twin Oak Switch 345 kV Line		
6	Barrilla-Linterna 138 kV Line		
7	Crockett-Grapeland Magnolia Tap 138 kV Line		
8	Lewisville Switch-Jones Street 138 kV Line		
9	Jones Street-Lakepointe 138 kV Line		
10	Twin Oak Switch-Oak Grove 345 kV Line		
11	Carterville-Eisl Tap 138 kV Line		
12	Saginaw-Blue Mound 138 kV Line		
13	Flat Top Tnp-Pig Creek Tap 138 kV Line		
14	Bruni Sub 138/69 kV Transformer		
15	Pave Paw-Like Oak 69 kV Line		
16	Austrop-Sandow Switch 345 kV Line		
17	Brays-Hiram Clarke 138 kV Line		

Legend **None** **Low** **High**

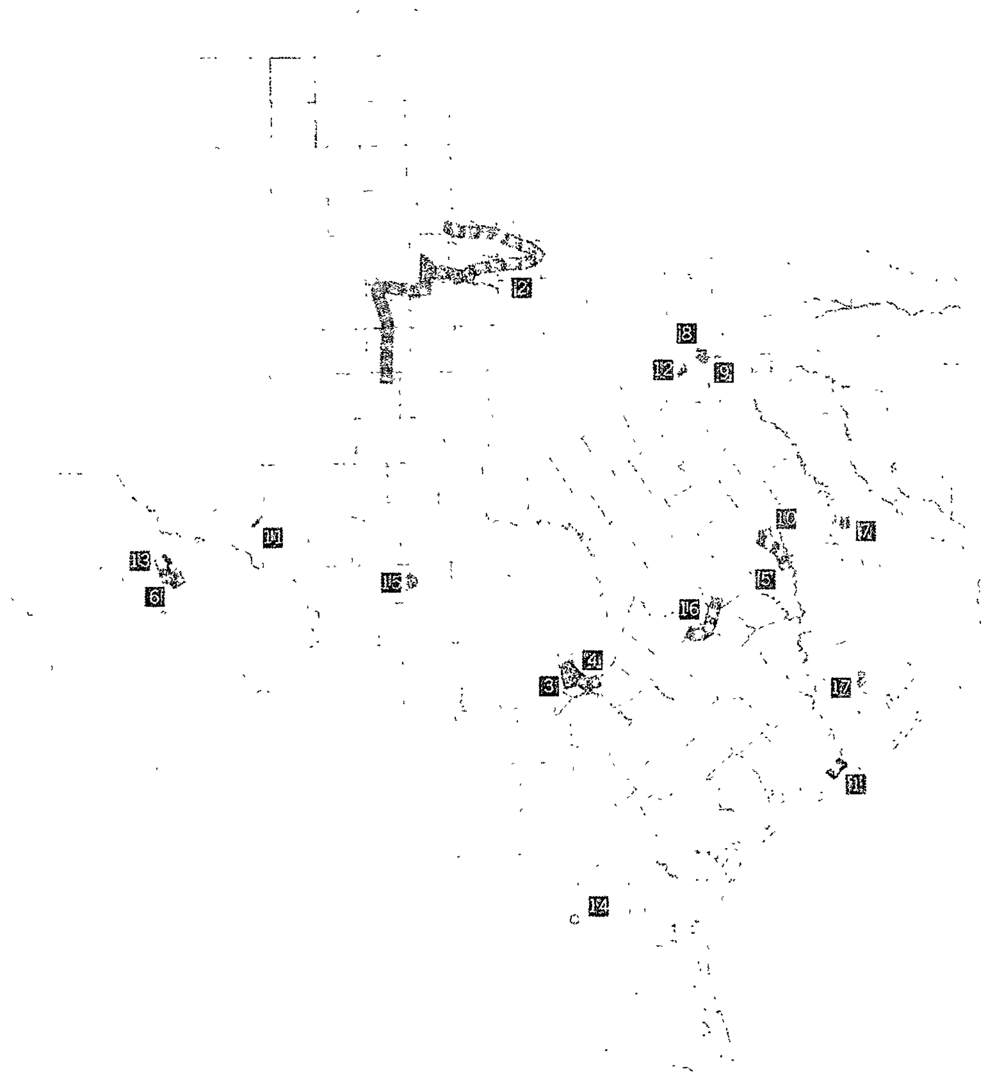

Figure 5.8: Projected 2020 and 2023 Constraints

Chapter 6. Load Integration

Recently, utilities either not currently connected to, or not fully connected to, the ERCOT grid have proposed switching all or parts of their systems into ERCOT. Following is a brief description of the Lubbock Power and Light and Rayburn Country Electric Cooperative proposals.

Lubbock Integration

Currently, the Lubbock Power and Light (LP&L) system is connected to the Southwest Power Pool (SPP) grid in the Eastern Interconnection. In 2015, LP&L expressed a desire to disconnect a majority of its system, including approximately 490 MW of load, from the SPP grid and connect it to the ERCOT grid. The PUCT asked ERCOT to perform an integration study for the LP&L system. Figure 6.1 shows the location of Lubbock relative to the ERCOT transmission system.

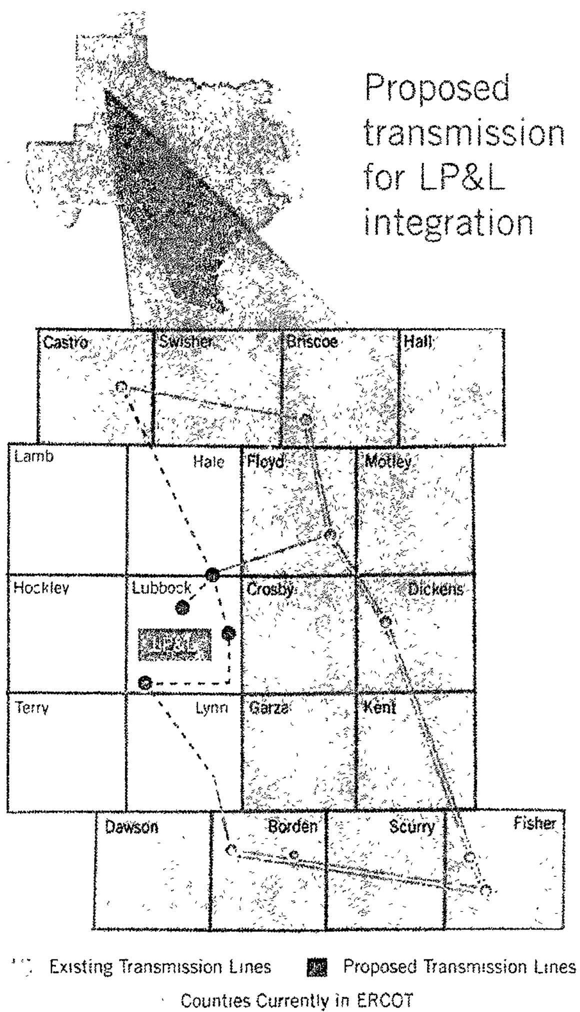

Figure 6.1: Lubbock Integration

ERCOT's Lubbock Integration study focused on identifying the most cost-effective transmission facilities necessary to integrate the LP&L system into the ERCOT grid while meeting the applicable reliability standards. The study, which was completed in June 2016, included a recommendation for the transmission facilities ERCOT preferred should LP&L integrate into the ERCOT grid. The recommended transmission facilities were estimated to cost $364 million.

Following ERCOT's filing of the Lubbock Integration study, the PUCT asked ERCOT and SPP to perform a full impact analysis of the potential LP&L system move to ERCOT. ERCOT and SPP jointly created a study scope for the analysis and then separately performed the requisite studies. Both ERCOT and SPP filed their impact studies with the PUCT in June 2017; these studies are available online in PUCT docket 47576. The PUCT is expected to determine if the LP&L system move to ERCOT is in the public interest in 2018.

Rayburn Country Electric Cooperative (RCEC) has a total peak load of about 1,000 MW. Most of this load is within the ERCOT system; however, approximately 190 MW is served from 138 kV transmission facilities within the Eastern Interconnection on the SPP grid. The 190 MW load served from the Eastern Interconnection is located in Kaufman, Van Zandt, Henderson and Anderson Counties. RCEC seeks to transfer this 190 MW load and most of the associated 138 kV transmission facilities from the Eastern Interconnection into ERCOT by December 2019 with the aim of having the entire RCEC load being served by ERCOT transmission facilities at the conclusion of this proposed transfer. RCEC and Lone Star Transmission performed a joint study and identified a preferred transmission interconnection option, with an estimated cost of $38 million, to integrate these facilities into the ERCOT grid.

The PUCT asked ERCOT to perform an integration study for the RCEC load. ERCOT concluded its study, agreeing with the RCEC and Lone Star Transmission preferred option. ERCOT filed the study report with the PUCT in June 2017 (available in PUCT docket 47342). The PUCT also asked ERCOT and SPP to perform a full impact analysis of the potential move. This impact analysis is expected to be completed in early 2018.

ERCOT currently has five asynchronous ties to other grids. There are two connections to the Eastern Interconnection with a total capacity of 820 MW. The other three ties are to the Mexican system and have a total capacity of 430 MW. These ties allow for ERCOT and the connecting grids to exchange power in emergencies and for entities to trade power between the grids on a commercial basis.

Southern Cross Transmission has proposed building a 2,000 MW merchant tie between ERCOT and the Eastern Interconnection. The tie would connect into the existing ERCOT system in Rusk County and in the Eastern Interconnect would terminate in eastern Mississippi. Power would flow between terminals via an approximately 400-mile High Voltage Direct Current (HVDC) line. The developer expects to begin commercial operation in the third quarter of 2022.

The PUCT has granted conditional approval for the facilities necessary to connect the Southern Cross project to ERCOT. However, due to the unique commercial nature and size of the tie, the PUCT has asked ERCOT to complete 14 directives to accommodate the project. The outcome of some of the directives may include changing ERCOT Bylaws, Protocols, or guides. ERCOT began working with stakeholders on these directives in 2017.

For general communications and queries, the public can submit a request for information at: http://www.ercot.com/about/contact/inforequest

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Users must obtain a digital certificate for access to this area. Folders in this area include data, procedures, reports and maps for both operations and planning purposes. Helpful information that can be found on this site includes the following:

- Generation Project Interconnection Information
- Regional Planning Group Information
- Steady-State Base Cases
- System Protection Data

This report was prepared by the Electric Reliability Council of Texas (ERCOT) staff. It is intended to be a report of the status of the transmission system in the ERCOT region and ERCOT's recommendations to address transmission constraints. Transmission system planning is a continuous process. Conclusions reached in this report can change with the addition (or elimination) of plans for new generation, transmission facilities, equipment, or loads. Information on congestion costs presented herein is based on the most recent settlement calculations at the time of the development of this report. Future settlements as well as ERCOT Board of Directors and Public Utility Commission of Texas directives may change the figures presented herein.

Far West Texas Project 2

ERCOT REGIONAL PLANNING GROUP SUBMITTAL

Feb 01, 2018

ASSETS PLANNING
DISTRIBUTION AND TRANSMISSION
BUSINESS AND OPERATIONS SERVICES

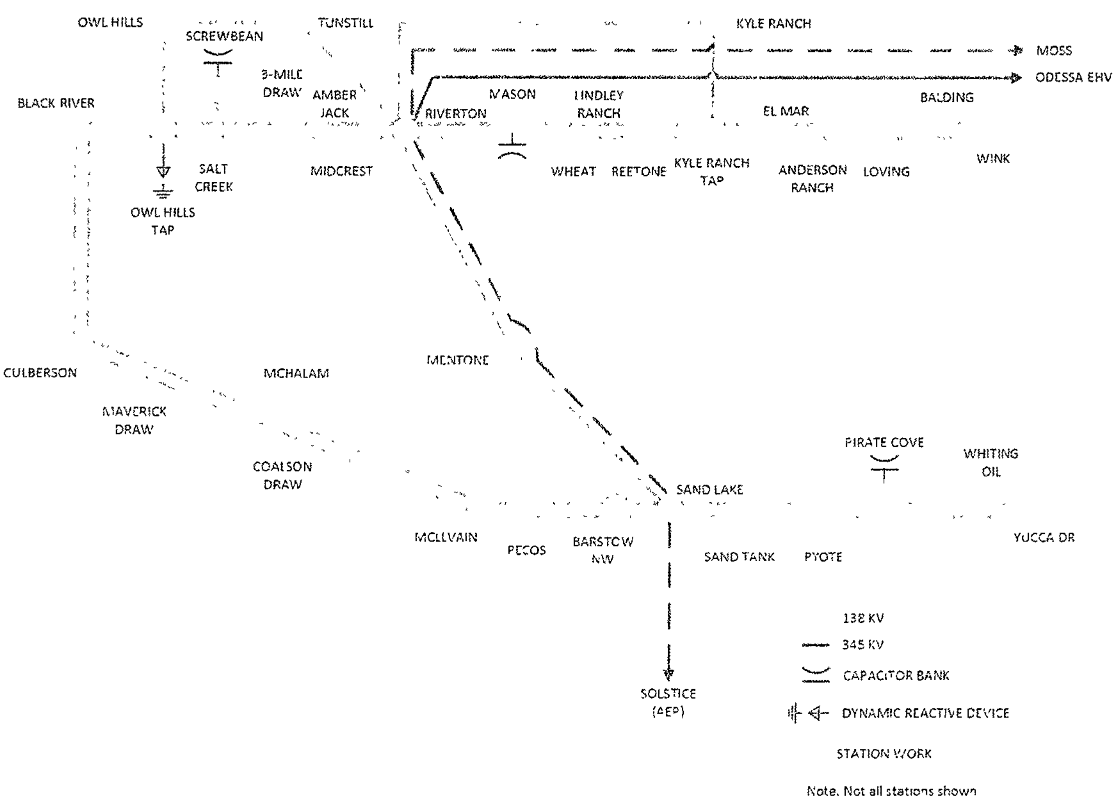
ONCOR®

Table of Contents

Executive Summary

Oncor proposes to construct the Far West Texas Project 2, a Far West Zone transmission project consisting of the following elements:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with one circuit in place from Sand Lake Sw. Sta. to Solstice Sw. Sta. Oncor will build half the line from Sand Lake and AEP will build half the line from Solstice.
- Sand Lake 345 kV Sw. Sta. additions including two 600 MVA, 345/138 kV autotransformers.
- Install the second circuit on the Riverton –Sand Lake 345 kV Line structures. Connect the new circuit from Riverton 345 kV Sw. Sta.to Sand Lake 345 kV Sw. Sta. to create the new Riverton – Sand Lake 345 kV Line.
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV Line structures (Moss – Riverton 345 kV Line)
- Construct the new Kyle Ranch Tap 138 kV Sw. Sta. in the Wink – Riverton double-circuit 138 kV Line
- Construct a new approximately 20-mile 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Sw. Sta.
- Construct a new approximately 20-mile 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Substation to Riverton 138 kV Sw. Sta.



This $194 million Tier-1 project in Reeves, Loving, and Pecos counties is recommended for construction to meet a Summer 2023 in-service date. This projected date may change based on requirements surrounding timing for environmental assessment, certification/licensing request and regulatory approval, land/rights-of-way acquisition, or other project related requirements. The need date may also be sooner based on the timing of new load additions in the area.

In June 2017, the ERCOT Board of Directors approved a portion of the Far West Texas Project, which included construction of two new 345 kV lines and autotransformer additions. In ERCOT's independent review of the project, ERCOT indicated that the approved project could serve up to 717 MW along the Oncor Wink – Culberson Yucca Drive – Culberson 138 kV transmission lines (The Culberson Loop) before other transmission system improvements would be required. ERCOT also identified future augmentations to the approved project that could serve up to 1037 MW.

Oncor has contractually confirmed load additions of 1013 MW that surpass ERCOT's indicated 717 MW limit for the approved Far West Texas Project. Additionally, known potential load additions may bring the total to 1339 MW. With these additions of load, expansion of the approved Far West Texas Project is needed to address reliability requirements and ensure the transmission system in the area is able to meet this load demand.

The Far West Texas Project 2 will complete the 345 kV loop between Riverton and Solstice, providing additional injection points into Oncor's Wink – Culberson - Yucca Drive 138 kV transmission lines (The Culberson Loop). The project will also add new network connections that will increase reliability, provide additional load serving capacity, support voltage conditions, enable clearances, and increase operational flexibility.

Introduction

This report describes the need to construct the Far West Texas Project 2 in Loving, Reeves, and Pecos counties.

In June 2017, the Electric Reliability Council of Texas (ERCOT) Board of Directors approved a portion of the Far West Texas Project, a Tier 1 transmission project to address several unacceptable voltage and transmission facility loading conditions on Oncor and American Electric Power (AEP) facilities in the far west region. ERCOT's analysis of the project reviewed immediate system needs based on existing loads and loads with signed Facility Extension Agreements (FEAs). As such the approved project elements were a subset of the proposed Far West Texas Project and included the new radial Odessa EHV – Riverton 345 kV Line, the new radial Bakersfield – Solstice 345 kV Line, two 345/138 kV autotransformers at Riverton, and two 345/138 kV autotransformers at Solstice.

In the independent review for the Far West Texas Project, ERCOT performed voltage stability analysis which indicated that the maximum load serving capability for the approved project was 717 MW along Oncor's Wink – Culberson 138 kV Line and the Yucca Drive – Culberson 138 kV Line, referred to as The Culberson Loop. ERCOT also indicated future expansion options for the Far West Texas Project to increase the load serving capacity up to 1037 MW. Expansion options included the need to connect the two radial 345 kV lines and install a Synchronous Condenser.

Oncor has continued to see large load growth along these transmission lines due to expansion of the oil and natural gas industry and recently submitted the Far West Texas Dynamic Reactive Devices (DRD) Project in December 2017 to address near term load increases in the 2019 timeframe. Additional large requests for electric service along these lines have been received, which will require expansion of the Far West Texas Project elements approved in 2017, including connection of the radial Odessa EVH – Riverton and Bakersfield – Solstice 345 kV Lines.

Purpose and Necessity

Load Growth

Oncor has continued to see load growth in the Delaware Basin served by Oncor's existing Wink – Culberson 138 kV Line and the Yucca Drive – Culberson 138 kV Line, referred to as The Culberson Loop. Since the RPG approval of the Oncor/AEP Far West Texas Project in May 2017, Oncor has continued to receive numerous new load additions from HV customers, many of which have requested in-service for their facilities beginning in the year 2018. As a result, Oncor recently submitted the Far West Texas DRD Project submittal, in which confirmed load service requests had reached 790 MW by 2022.

The immediate urgency for the Far West DRD Project is driven by needs to address operational and reliability issues before the new 345 kV lines can be built. Further long-term improvements for the region are still needed as the net load in The Culberson Loop continues to grow beyond the current capacity. Both during and after Oncor completed its Far West Texas DRD Project studies, Oncor has continued to see new contracted loads that will increase the total peak load served in The Culberson Loop to 1013 MW.

Table 1 below shows the confirmed load requests and the total projected non-coincident summer peak loads for The Culberson Loop. The values shown under Confirmed Load Requests includes only confirmed additions through the ERCOT 2017 Annual Load Data Request (ALDR) process and high voltage (HV) customers with contractually signed obligations. This data alone, however, provides an incomplete picture of the future load in this area because it fails to consider future load growth beyond what is contractually committed at the moment of study. In addition to new customers that have signed agreements, there are a number of new load additions in discussion that could potentially add approximately 300 MW of load to The Culberson loop beyond the load totals described above. The Total Projected Load Additions shown in Table 1 include pending additions that are in the study and contractual discussion stages between Oncor and customers, and have a probable likelihood of bringing the total load served in the loop to 1339 MW by 2023.

	Confirmed Load Requests					
	2017	**2018**	**2019**	**2020**	**2021**	**2022**
Total (MW)	**300.6**	**580.2**	**775.4**	**893.0**	**964.4**	**1013.1**
	Total Projected Load Additions					
Total (MW)	**300.6**	**670.3**	**983.8**	**1163.4**	**1292.0**	**1339.8**

Table 1- Total Projected Load (MW) Served from The Culberson Loop

Table 2 below shows a timeline of how the total Oncor load forecast for The Culberson Loop has changed over the last few years. The Total Load Forecast column shows what the total confirmed load projection was at the particular time shown in the Forecast Date column. The Timing Description column shows what RPG project was in progress at that same particular time.

Forecast Date	Total Load Forecast	Timing Description
02/2013	148 MW	Permian – Culberson Submittal
02/2016	252 MW	Riverton – Sand Lake Submittal
04/2016	425 MW	Far West TX Project Submittal
05/2017	596 MW	Far West TX Project Approval
10/2017	790 MW	Far West DRD Project Submittal
01/2018	1013 MW	Far West TX Project 2 Submittal
01/2018	1339 MW (w/load under discussion but unsigned)	Far West TX Project 2 Submittal

Table 2- Projected Load (MW) Served from The Culberson Loop Timeline

This table illustrates the rapid new load requests this area of the ERCOT system has received in a relatively short time frame and the need for system planning in this area to extend beyond contractually committed loads. The speed of growth at which many of these customers are coming online makes it difficult to construct and operate facilities to adequately serve the load in a timely fashion, makes accurately studying this area of the ERCOT system difficult, and results in plans that are potentially insufficient shortly after they are created. Restricting planning to the contractually committed load forecast for projects in this area provides no margin of error for this rapid growth.

For example when Oncor submitted the original Far West Texas Project to RPG in 2016, the forecast at that time for 2021 was 425 MW. Today Oncor forecasts that its 2018 peak load for this area will be 580 MW. Another good example of this dramatically increasing load growth is the load additions that occurred during the course of Oncor's preparation of the DRD project submittal. During Oncor's studies, the ultimate totals for The Culberson Loop increased from 790 MW to 1013 MW in the span of a few months. In addition, the total load forecast for The Culberson Loop already exceeds ERCOT's expected load serving capability for the approved Far West Texas Project (717 MW), well before CCN applications can even be filed with the Public Utility Commission for the new 345 kV lines.

Based on this recent history, it is reasonable to expect that the total net load may increase throughout the RPG review process and will be higher upon completion of ERCOT's independent review. Planning beyond the signed contractual numbers is paramount for this area of the ERCOT grid which is seeing rapidly increasing load growth. As a result, Oncor recommends planning studies be performed beyond the contracted total load of 1013 MW and to the potential load of 1339 MW.

Base Case Analysis

In the original Far West Texas Project April 2016 submittal, Oncor identified numerous contingencies that resulted in unacceptable voltage conditions. Studies showed that in 2021, multiple P6 and P7 branch outages would result in unsolved contingencies during load flow analysis. ERCOT saw similar issues and performed sensitivity studies on the area as part of the RPG review process. ERCOT's independent review determined that as load grows in the area, further improvements to the approved Far West Texas Project would be needed. Ultimately ERCOT indicated that closing the 345 kV loop between Riverton, Sandlake, and Solstice would be needed if load reached 917 MW and the addition of a dynamic reactive device (DRD) such as a Synchronous Condenser would be needed if load reached 1037 MW.

The current confirmed and future potential forecast of 1013 MW and 1339 MW exceed ERCOT's original study thresholds. Due to the near term load increases in the 2018-2020 timeframe before the Odessa EHV – Riverton 345 kV Line can be built, Oncor recommended the acceleration of the reactive compensation piece of ERCOT's original Far West Texas Project recommendations with the Far West DRD Project.

With the new updated load totals, Oncor performed studies using the ERCOT Steady State Working Group (SSWG) 2023SUM case published in October 2017 and the ERCOT Dynamics Working Group (DWG) 2023SP case published in Spring 2017 as the base cases. Table 3 below shows a summary of the adjustments that were made to the cases for simulations in the updated study.

Case Adjustment	Description
Outage of West of Pecos Solar Generation	Outage of solar generation to simulate night time conditions.
Outage of Permian Basin SES Generation	Permian Basin is normally fully dispatched in the ERCOT Regional Transmission Plan (RTP) base cases as well as the Steady State Working Group (SSWG) base cases. However in real-time

	operations, Permian Basin is not normally running and is not intended to be a 24/7 continuous operating generator. As a result, Permian Basin generation being offline is a reasonable scenario and a variation that would more closely mimic real-time operations. The results of studies in this area demonstrate worse operating conditions when the Permian Basin Plant generation is unavailable, and should be considered in analysis.
Updates for confirmed load additions (Total 1013 MW)	New HV points-of-delivery (PODs) and existing substation load updates were made per the MW values shown in Table 1 within The Culberson Loop. Load point changes can be found in the project file submissions.
Updates for potential load additions (Additional 326 MW)	New HV points-of-delivery (PODs) were added based on the expected connection locations and load projections provided by customers currently in the contractual discussion process. These customers and their data are considered private and confidential.
Addition of the Far West Texas DRD Project	Two 250 MVAR, 138 kV STATCOMs at Owl Hills Tap Sw. Sta. Please see Oncor's Far West Texas DRD RPG Submittal from December 2017 for details.

Table 3- Base Case Adjustments

Oncor studies show that even with the approved Far West Texas Project and dynamic reactive devices in place, the increased load additions will result in additional violations of the NERC standard TPL-001-04 reliability criteria. Steady state contingency analysis for the 2023 base case shows that loss of the radial Odessa EHV – Riverton 345 kV Line, a NERC category P1.2 contingency, results in multiple voltage violations along The Culberson Loop. Figure 1 below shows the voltage response of buses along The Culberson Loop when opening this line without a fault, while Figure 2 below shows the single circuit outage without a fault.

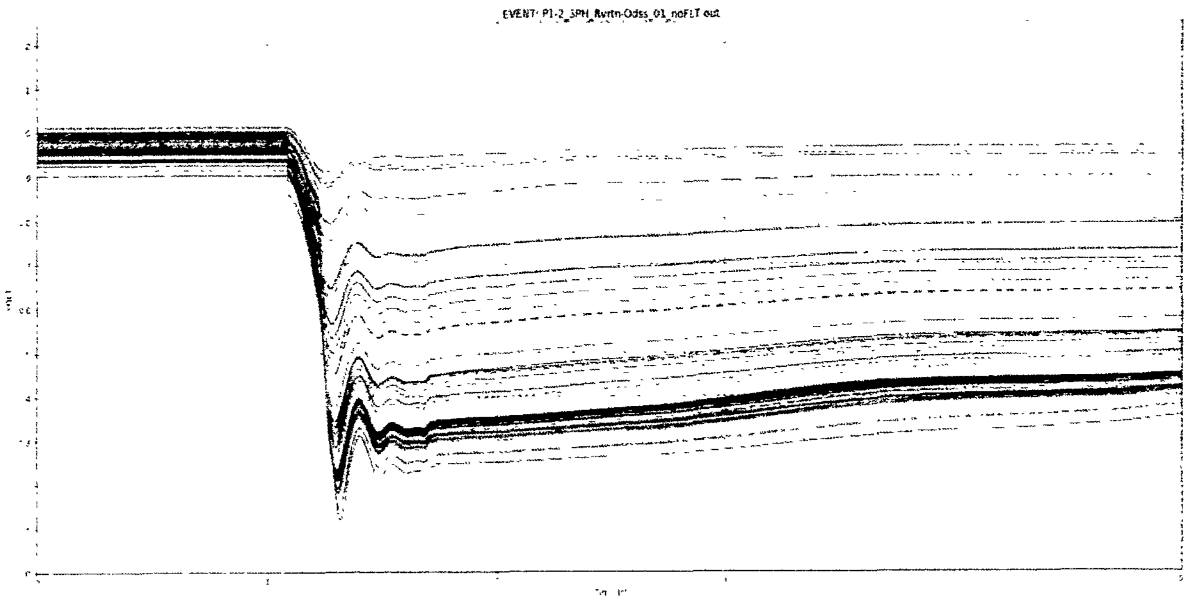


Figure 1 – Loss of Odessa EHV – Riverton 345 kV Line Voltage Response (No Fault)

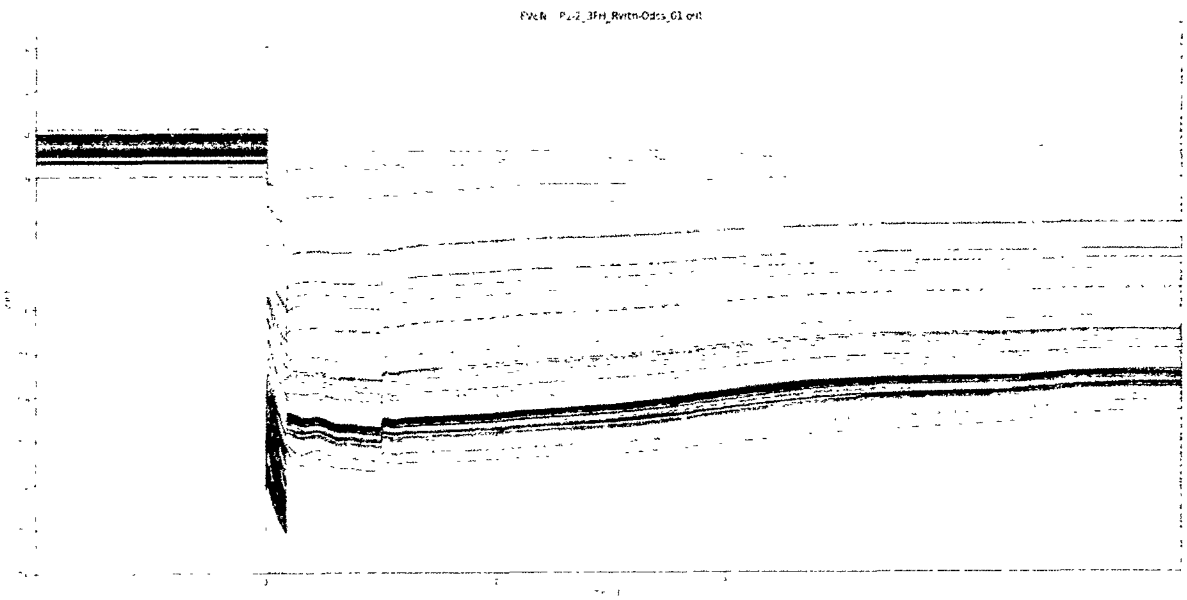


Figure 2 – Loss of Odessa EHV – Riverton 345 kV Line Voltage Response (With Fault)

The result indicates that a single-line outage of the radial 345 kV transmission line will result in a service interruption to all customers served within The Culberson Loop (1013 MWs of load in 2022). This analysis also indicates that taking a clearance on the radial 345 kV line will be problematic. As a result, there is an urgent need to close the loop and create an alternative transmission feed for the 345 kV source at Riverton when the load reaches the 1013 MW level. Creating this bi-directional feed would address these criteria violations and increase operational flexibility of the radial 345 kV line. It should be noted that this need date may be sooner, potentially as soon as 2020, based on potential load additions that are currently in contractual discussion as shown in Table 1.

Steady state contingency analysis for the 2023 base case identified additional category P1.2 and P7.1 contingencies that resulted in voltage violations under NERC Standard TPL-001-4 reliability criteria. There are six (6) different contingencies that result in the remaining line sections of The Culberson Loop to be insufficient to maintain adequate system operating conditions, resulting in an unsolved power flow. In addition, there are fifteen (15) different contingencies that result in multiple buses in The Culberson Loop being below acceptable voltage limits.

These studies show that multiple contingencies result in buses along The Culberson Loop being unable to recover to acceptable voltage levels as defined in the ERCOT Planning Guide Section 4.1.1.4. Acceptable voltage limits are defined as 0.90 per unit to 1.05 per unit in the post-contingency state following the occurrence of any operating condition in categories P1 through P7. These scenarios would ultimately result in loss of service to these customers.

Figure 3 below shows the same voltage response after loss of the Odessa EHV – Riverton 345 kV Line at the confirmed 1339 MW load level with the 345 kV loop closed. While voltage levels are able to eventually recover to acceptable levels post-contingency, there is some uncertainty as seen in the fluctuations prior to recovery. This particular simulation assumed that 10% of customer motors included voltage protection set to trip if their respective bus voltages were below 0.80 PU for 30 cycles. The abrupt vertical change in the plot at about 1.5 seconds indicates that many customer motors did trip on voltage protection during the simulation.

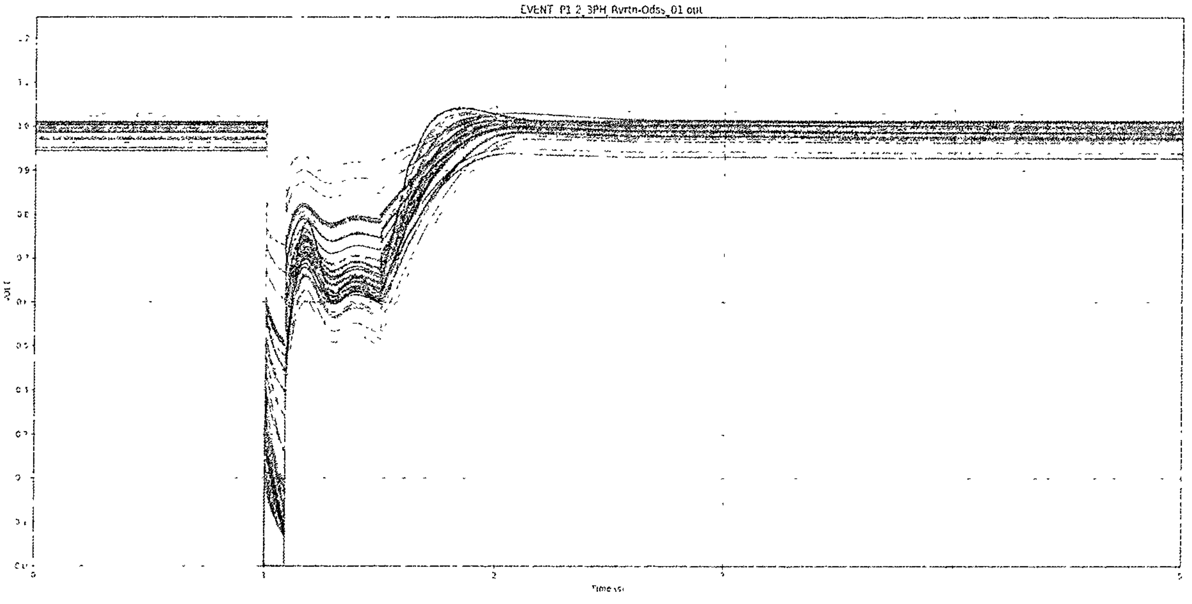


Figure 5 – Dynamic Voltage Response of The Culberson Loop for P1.2 (Odessa EHV – Riverton 345 kV Line)

Uncertainties in customer's motor behavior and protection create unknowns in the study results since estimations must be made for the dynamic load models. Majority of the loads served within The Culberson Loop are oil and gas customers who employ voltage sensitive electric equipment and motors in their operations, and have varying operational practices and philosophies on protection of their equipment. This increases the need for some margin to be provided in the proposed solution beyond the contracted load amount. Otherwise, the reliability of the transmission grid in the area could be dependent on customer owned protection and customers tripping their load. Furthermore, there is no indication that the system would support reconnection of customer load during this compromised condition.

Operational Concerns

Oncor currently has remedial operational schemes in place to mitigate post-contingency voltage violations in the area until additional facilities can be built to reliably serve the increasing load. Additional operation schemes will be needed as load within The Culberson Loop continues to grow. This may include various low voltage load shed schemes, transfer trip schemes, and load restoration procedures. In some instances, these measures will prevent the ability to reclose after a system event and prohibit eventual restoration of customers' electricity service. They may also limit operational flexibility in switching out failed equipment and restoring loads radially, putting potentially hundreds of megawatts at risk depending on the outage scenario.

As shown above in studies, taking an outage of the radial Odessa EHV – Riverton 345 kV Line may be problematic due to the reliance on the circuit for reliability of the area. This will only make an already difficult area to operate more difficult since this area of the transmission system has limited amount of transmission infrastructure. As load grows in the area, this system will become heavily reliant on the lone 345 kV source.

Table 4 shows a comparison matrix of the various stages of The Culberson Loop transmission system. Many contingencies result in significant consequential load loss. In addition, Under Voltage Load Shed (UVLS) will be required to restore the system to acceptable voltage levels. Since there are currently no mitigation alternatives to UVLS for restoring system voltage within The Culberson Loop, the out-of-service load will remain without power until the initiating problem can be corrected.

Year/Season	Load Level (MW)	Outage	NERC Category	Consequential Load Loss (MW)	Minimum UVLS (MW)	Max Load at Risk (MW)	Max Load at Risk (Percent of Total)
2018 Spring	470	Specific contingency definitions redacted for security purposes.	P7	169	65	234	50%
			P7	164			
			P7	114			
			P1	105			
2018 Fall	521		P7	190	70	260	50%
			P7	173			
			P7	120			
			P1	108			
2019 Spring	647		P7	217	75	292	45%
			P1	112			
			P1	105			
2019 Fall	655		P7	223	75	298	45%
			P7	150			
			P1	116			
			P1	107			
2022 Fall	1013		P7	441	75	516	51%
			P1	295			
			P7	152			
			P1	146			
			P7	127			
			P1	103			

Table 4 - Potential Loss of Load

As the system topology changes and more load is connected, these temporary operational measures will likely remain in place to provide margin and mitigate unresolved issues until projects are constructed. It should be noted that with the large number of new HV customers being connected to these lines over the next couple years, there will be a significant number of planned outages along The Culberson Loop, further adding to the complexity of operating the system in this area and consistently placing these lines in an N-1 state. As a result, this area of the system will present multiple operational challenges until appropriate facilities such as the Far West DRD Project and the future 345 kV infrastructure are built. While these temporary solutions are not project alternatives, they will be needed since studies show that, without these solutions in place, the system cannot maintain post-contingency system voltage in accordance with NERC TPL-001-4 requirements.

Project Description

The original Far West Texas Project RPG submittal in 2016 included a full 345 kV loop between Odessa EHV, Moss, Riverton, Sand Lake, Solstice, and Bakersfield. In addition, it included provisions for future load growth by enabling the installation of new autotransformers at stations along the proposed 345 kV transmission lines. This proposed project would complete the original proposed project by closing the 345 kV loop and installing additional autotransformers to mitigate the previously discussed violations. In addition, new 138 kV network connections are recommended to provide additional voltage support and load serving margin.

The proposed project estimated cost is $194 million and consists of the following elements:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with one circuit in place from Sand Lake Sw. Sta.to Solstice Sw. Sta. Oncor will build half the line from Sand Lake and AEP will build half the line from Solstice.
- Expand the Sand Lake Sw. Sta. to install a 345 kV ring-bus arrangement with two 600 MVA, 345/138 kV autotransformers.
- Install the second circuit on the Riverton –Sand Lake 345 kV Line structures. Connect the new circuit from Riverton 345 kV Sw. Sta.to Sand Lake 345 kV Sw. Sta. to create the new Riverton – Sand Lake 345 kV Line.
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV Line structures (Moss – Riverton 345 kV Line)
- Construct the new Kyle Ranch Tap 138 kV Sw. Sta. in the Wink – Riverton double-circuit 138 kV Line
- Construct a new approximately 20-mile 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Sw. Sta.
- Construct a new approximately 20-mile 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Substation to Riverton 138 kV Sw. Sta.

Second 345 kV Circuit

As shown in the studies, outage of the radial Odessa EHV – Riverton 345 kV Line will be prohibitive. As a result, addition of the 2nd circuit to the approved Odessa EHV – Riverton 345 kV Line was considered and would thus address the single circuit outage concerns. The second circuit would physically share common structures with the Odessa EHV – Riverton 345 kV Line, but would electrically be connected from the Moss 345 kV switching station. Hence the second circuit would be the new Moss – Riverton 345 kV Line, which is estimated to be 85 miles.

The addition of the second 345 kV circuit would address the P1.2 contingency concerns. The voltage response after loss of the Odessa EHV – Riverton 345 kV Line is shown below in Figure 6.

Figure 6 – Dynamic Voltage Response of The Culberson Loop for P1.2 (Odessa EHV – Riverton 345 kV Line)

Constructing the second circuit at the same time as the initial circuit would provide economic cost savings, address the P1.2 contingency, and increase operational flexibility in taking an outage on the single 345 kV circuit. In addition, it takes advantage of mobilized resources during initial construction of the Odessa EHV – Riverton 345 kV Line and avoids the need to return for construction on a newly built transmission facility. Oncor estimates the additional cost to install the second circuit during the construction of the Odessa EHV – Riverton 345 kV Line to be $32m (included in the proposed project estimate). This cost is approximately 50% less than the cost of coming back to install the second circuit at a later time due to reduced access, environmental and mobilization costs in addition to significant construction efficiencies.

New 138 kV Lines

In order to provide transmission facilities necessary to interconnect new customer loads in the area, Oncor has multiple projects to construct new 138 kV lines in the area. Example projects include the Riverton – Sand Lake 138 kV Line, Riverton – Tunstill 138 kV Line, and Orbison Tap – Balding 138 kV Line. With multiple radial taps being extended from the main lines of The Culberson Loop, there are concerns for reliability and operational flexibility, especially with the large size of these loads.

Interconnecting some of these radial lines and converting service from radial to normal looped service would not only address reliability concerns for the radially served loads, but also strengthens the transmission system by creating a more networked system to support voltage conditions and allow operationally flexibility for outages.

Oncor currently has plans to extend radials for the Owl Hills Tap – Owl Hills 138 kV Line and the Kyle Ranch Tap – Kyle Ranch 138 kV Line for new load serving substations within the Delaware Basin. These radial line extensions to serve new loads are Tier 4 Neutral projects in accordance with ERCOT Protocol

Section 3.11.4.4 (e). These new loads were included in the base case analysis with CCN filings planned by Oncor in the near future.

Ultimately, connecting these lines back to another switching station, such as Riverton, will provide such network connections and provide further paths for the future planned 345 kV injection point there.

Oncor studies showed that at the 1339 MW level, these new 138 kV connections could successfully mitigate the voltage violations mentioned previously in addition to the operational and reliability benefits described. This also provides additional transmission infrastructure in areas where little to none exists, and provides infrastructure to establish substations closer to customer's locations in the Delaware Basin.

Diagram

Figure 7 below shows the diagram of the proposed Far West Texas Project 2. The dotted lines depict the transmission line elements and the yellow depicts associated station work of the proposed Far West Texas Project 2.

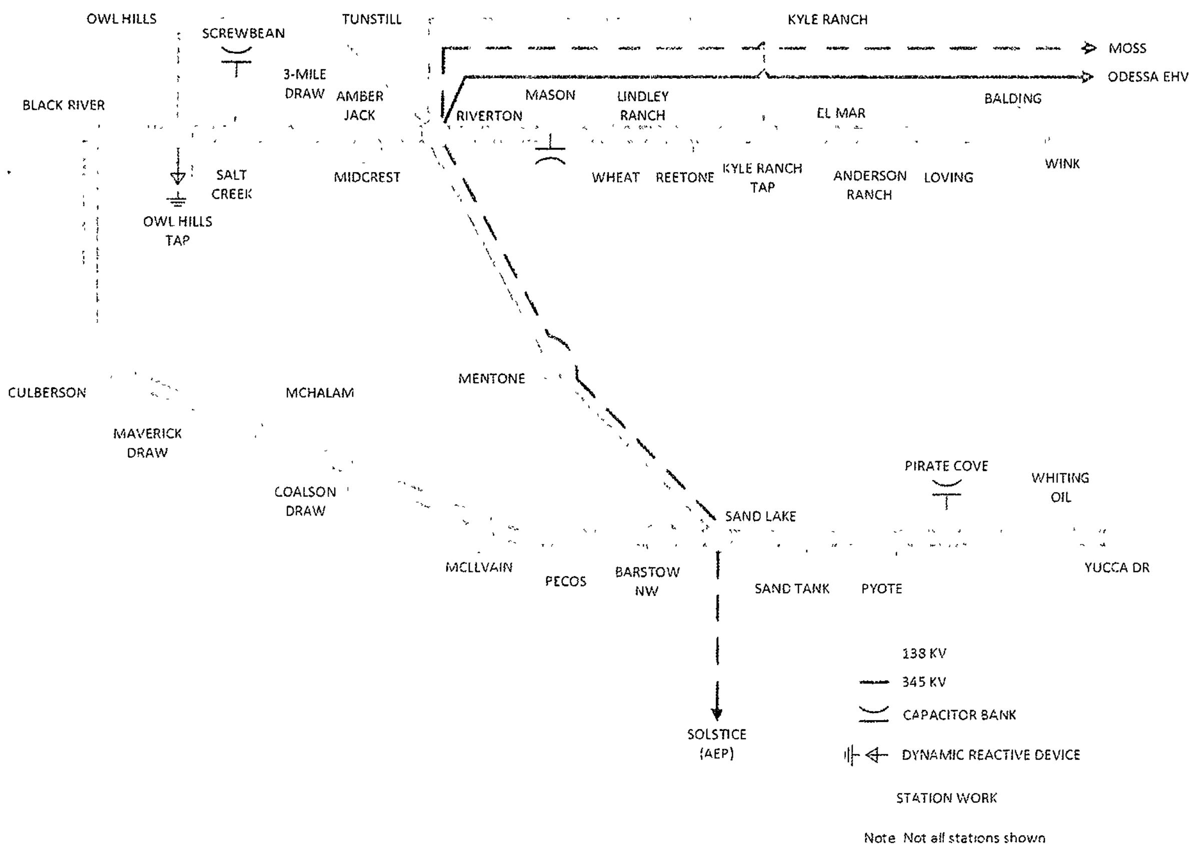


Figure 7 –Diagram

Alternatives

In ERCOT's independent review of the Far West Texas Project, ERCOT reviewed up to 40 different alternatives to the original proposed Far West Texas project. The alternatives included variations of different 138 kV and 345 kV transmission lines and reactive compensation devices.

In its evaluation of the alternatives, ERCOT identified two main options to augment the ultimately approved Far West Texas Project. Both options involved closing the 345 kV loop with added autotransformer capacity at Sand Lake Sw. Sta.

Option 1

- Addition of the 345 kV Line between Riverton – Sand Lake
- Installation of one 345/138 kV autotransformer at Sand Lake
- Construction of new 345 kV Line from Sand Lake to Solstice

Option 2

- Addition of 345 kV Line between Riverton – Sand Lake
- Installation of one 345/138 kV autotransformer at Sand Lake
- Construction of new 345 kV Line from Sand Lake to Solstice
- Installation of 200 MVAR Synchronous Condenser at Culberson

ERCOT's study for the Far West Texas Project indicated that the load serving capacity within the Culberson Loop for Option 1 would be up to 917 MW and for Option 2 up to 1037 MW. In combination with Oncor's recently submitted Far West DRD Project, Oncor's proposed solution closely mirrors ERCOT's recommended Option 2 by closing the 345 kV loop and adding dynamic reactive support.

With the current forecast (1013 MW) approaching the load serving capacity of ERCOT's Option 2 (1037 MW) and the potential 1339 MW load level imminent, additional expansion from the full build out of the Far West Texas Project is needed. As mentioned previously, the need to plan and build facilities beyond the signed contractual numbers is paramount for this area. This is especially important for future 345 kV improvements which need sufficient margin in order to ensure a robust and resilient solution for the area.

Installation of the new Far West Texas DRDs alone will not address new planning criteria violations that result from the increases in load. In addition, the DRDs alone would not close the 345 kV loop, leaving both the Odessa EHV – Riverton and the Bakersfield – Solstice 345 kV lines in radial configurations and susceptible to single outages. As mentioned previously in this report, single contingency loss of the Odessa EHV – Riverton 345 kV line, and the subsequent outage of the two Riverton 345/138 kV autotransformers results in unacceptable voltage conditions in The Culberson Loop.

Another relatively straight forward alternative to augment the existing project is to complete the full 345 kV loop between Odessa EHV – Moss – Riverton – Sand Lake – Solstice – Bakersfield as full double-circuit 345 kV lines. While this would increase operational flexibility and aid the voltage recovery post-contingency, Oncor studies show that this alone would not address individual contingency violations within the Culberson Loop at the 1339 MW level. Oncor steady-state analysis showed that there would still be multiple contingencies that would result in the remaining buses in The Culberson Loop to be below acceptable ranges.

Subsynchronous Resonance Impact

A topology screening assessment was performed to identify new potential Subsynchronous Resonance (SSR) vulnerabilities within the ERCOT system as a result of the proposed project. The assessment revealed that system changes required by the proposed project did not result in any generation resources becoming radial to series capacitors in the event of less than 14 concurrent transmission outages.

Recommendation

Oncor recommends completion of the original 2016 Far West Texas Project by closing the 345 kV loop between Riverton and Solstice and installing autotransformers at Sand Lake. Additionally, Oncor recommends that the second circuit on the Odessa EHV – Riverton 345 kV Line structures be installed at the same time, as well as the addition of two new 138 kV network connections to provide additional voltage support and load serving margin within The Culberson Loop. These projects will effectively mitigate reliability issues, provide transmission infrastructure for future loads to connect, and ensure infrastructure needs are addressed for the Delaware Basin.

Eithar Nashawati
Director, Assets Planning

ONCOR

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May 14, 2018

Chad V. Seely
Vice President, General Counsel and Corporate Secretary
Electric Reliability Council of Texas, Inc.
7620 Metro Center Drive
Austin, TX 78744

Dear Mr. Seely:

This letter is a formal request by Oncor Electric Delivery (Oncor), AEP Service Company (AEPSC), and LCRA Transmission Services Corporation (LCRA TSC) for the Electric Reliability Council of Texas (ERCOT) to grant critical designation status for the Riverton – Sand Lake 345 kV Line, Sand Lake - Solstice 345 kV Line, and the Bakersfield - Solstice 345 kV Line projects.

Both the Riverton - Sand Lake and Sand Lake - Solstice 345 kV lines and their associated station work are currently being reviewed by stakeholders and ERCOT through the ERCOT Regional Planning Group (RPG) Project Review Process, as part of The Far West Texas Project 2. Oncor submitted this project to the RPG on Feb 1, 2018. The Bakersfield - Solstice 345 kV Line and its associated station work was previously reviewed by the ERCOT RPG as part of the original Far West Texas Project. The Bakersfield – Solstice 345 kV Line received approval by the ERCOT Technical Advisory Committee (TAC) in May 2017 and by the ERCOT Board of Directors in June 2017.

The original Far West Texas Project as submitted to the RPG on April 20, 2016, proposed, among other things, the new Riverton - Sand Lake and Sand Lake - Solstice 345 kV Lines as part of a new 345 kV transmission loop in Far West Texas. ERCOT did not approve these pieces of the project in its Independent Review of the Far West Texas Project dated May 23, 2017 based on the load projections for the area at the time. At that time, the committed load on the existing Oncor Wink - Culberson Switch 138 kV Line and the Oncor Yucca Drive Switch - Culberson Switch 138 kV Line (together referred to as The Culberson Loop) was expected to be approximately 600 MW by 2022.

In ERCOT's Independent Review of the Far West Texas Project, it indicated that closing the 345 kV loop from the Riverton to Sand Lake to Solstice switching stations would be needed when the load level on The Culberson Loop reached 917 MW, and an additional Dynamic Reactive Device would be needed when that load reached 1037 MW. Since that time, load growth in the area has significantly outpaced the original study projections for the project. As of February 1, 2018, Oncor has contractually committed load requests that will cause the total peak load served by The Culberson Loop to exceed 1000 MW in 2022. With the current forecast fast approaching the load serving thresholds indicated by ERCOT's Independent Review, these scope additions to the original Far West Texas Project are needed as soon as possible.

Recent studies for when The Culberson Loop load reaches over 1000 MW show that the loss of the radial Odessa EHV – Riverton 345 kV Line, a NERC category P1.2 contingency, or the loss of the double circuit Odessa EHV – Riverton 345 kV Line (if a second circuit is approved between Moss and Riverton), a NERC category P7 contingency, result in multiple voltage violations and service interruption to all customers served within The Culberson Loop (1013 MW of load in 2022). This analysis also highlights the impact that taking a clearance on the radial 345 kV line will have on customers since a 345 kV source is critical to maintaining service to customers served on The Culberson Loop.

It should be noted that the load may develop sooner than 2022, potentially as soon as 2020, based on potential load additions that are currently in contractual discussion with Oncor. As of May 1, 2018, the potential load to be served in The Culberson Loop could reach over 1600 MW based on the summation of current customer inquiries. The speed at which many of these customers are coming online has already proved the difficulty to planning, designing, constructing and operating facilities to adequately and reliably serve the load in a timely fashion. The high rate of growth in this area of the ERCOT system makes incremental "wait-and-see" plans for transmission facility improvements insufficient for reliable, "on-time" service to customers.

As a result, in order to continue to provide reliable service to significant load in Far West Texas, there is now a critical need to close the previously considered 345 kV loop and create an alternative transmission feed for the 345 kV source at Riverton as soon as possible. Creating this bi-directional feed would address the previously discussed reliability criteria violations, reduce the potential for load shedding events, and increase operational flexibility of the radial Odessa EHV – Riverton 345 kV line.

The Riverton – Sand Lake 345 kV Line is a necessary component required to close the 345 kV loop from Riverton to Sand Lake to Solstice. After RPG review, in January 2017 ERCOT recommended Oncor's Riverton – Sand Lake 138 kV Line project, recommending it to be constructed to 345 kV standards but operated initially at 138 kV. Oncor filed its CCN application as such on July 21, 2017, with a final decision due from the Public Utility Commission of Texas (PUCT) before July 21, 2018. Currently, a Proposal for Decision (PFD) is expected to be reviewed at the PUCT Open Meeting on May 10, 2018, in which there were no exceptions filed to the PFD's recommendation to approve the project. Assuming the new Riverton – Sand Lake line will be constructed to 345 kV standards, ERCOT's critical designation for this line's upgrade to 345 kV operation will allow for a faster ability to place this new 345 kV circuit into service.

In addition to the Riverton – Sand Lake 345 kV Line, the Sand Lake – Solstice and the Bakersfield – Solstice 345 kV Lines are required to close the 345 kV loop. AEP Texas and LCRA TSC have been actively working on the CCN Application for the Bakersfield – Solstice 345 kV Line and plan to file with the PUCT for approval of this line in the Fall of 2018. Oncor and AEP Texas will be initiating appropriate environmental and routing assessments for the Sand Lake – Solstice 345 kV Line shortly, with plans to also file the CCN application in the Fall of 2018 concurrent with the Bakersfield – Solstice 345 kV Line application.

As mentioned in previous correspondence, Oncor is implementing remedial operational schemes to mitigate post-contingency voltage violations in The Culberson Loop area until additional facilities can be built to reliably serve the increasing load. This will include various low voltage load shed schemes, transfer trip schemes, and load restoration procedures. In some instances, these measures will prohibit timely restoration of customers' electricity service, putting potentially hundreds of megawatts of continuous process type customer loads at risk of extended service interruptions depending on the outage scenario. Without a looped 345 kV source supplying The Culberson Loop, reliably serving the expected 1000+ MW of load in that area will be problematic. As a result, a critical need exists in this area of the ERCOT system to relieve the multiple operational challenges through the construction and operation of the 345 kV infrastructure described in this letter.

It is for these multiple operational and reliability needs that Oncor, AEPSC, and LCRA TSC are requesting critical designation status for the Riverton – Sand Lake 345 kV Line, the Sand Lake – Solstice 345 kV Line, and the Bakersfield – Solstice 345 kV Line. With the critical designation and six month administrative review at the PUCT, the in-service dates for these projects could be accelerated by six months or more, which would allow the utilities to serve the committed load more reliably and minimize the timeframe the system would be subject to the operational risks described above. The needed 345 kV infrastructure is critical to the ability to reliably serve loads already interconnected as well as the expected load growth in this area of the ERCOT system.

Best regards,

Eithar Nashawati

Eithar Nashawati
Director – Assets Planning
Oncor Electric Delivery

Kristian M Koellner

Kristian Koellner
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June 12, 2018

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Director, Transmission Planning
Lower Colorado River Authority
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Austin, TX 78767-0220

RE: Far West Texas Dynamic Reactive Devices and Far West Texas Project 2

On June 12, 2018 the Electric Reliability Council of Texas (ERCOT) Board of Directors endorsed the following Tier 1 transmission project as needed to support the reliability of the ERCOT Regional transmission system:

Far West Texas Dynamic Reactive Devices and Far West Texas Project 2:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA, 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station

- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice Switch Station – Bakersfield Switch Station double circuit structures
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station

Further, the Board of Directors designated the Riverton – Sand Lake 345 kV line, the Sand Lake – Solstice 345 kV line, and the Bakersfield – Solstice 345 kV line critical to the reliability of the ERCOT System. Additional details on this project are included in the Attachment A to this letter.

This project was supported throughout the ERCOT planning process, which included participation of all market segments through the ERCOT RPG. ERCOT's recommendation to the Board was reviewed by the ERCOT Regional Planning Group and the ERCOT Technical Advisory Committee (TAC). ERCOT staff looks forward to the successful completion of the work and is ready to assist you with any planning and operations related activities.

Should you have any questions please contact me at any time.

Sincerely,

DW Rickerson

D. W. Rickerson
Vice President, Grid Planning and Operations
Electric Reliability Council of Texas

cc:
Shawnee Claiborn-Pinto, PUCT
Bill Magness, ERCOT
Cheryl Mele, ERCOT
Warren Lasher, ERCOT
Jeff Billo, ERCOT
Prabhu Gnanam, ERCOT

Attachment A

ERCOT Independent Review of Oncor Far West Texas Project 2 and Dynamic Reactive Devices

Version 1.0

Document Revisions

Date	Version	Description	Author(s)
05/21/2018	1 0	Final Report	Xiaoyu Wang, Ying Li, Priya Ramasubbu
		Reviewed by	Prabhu Gnanam, Shun Hsien (Fred) Huang, Jeff Billo

Table of Contents

1. Executive Summary

In June 2017, the ERCOT Board of Directors endorsed the Far West Texas Project (FWTP), a Tier 1 transmission project to address the transmission needs both in the Culberson Loop area and the Barilla Junction area that could reliably serve the Culberson Loop load up to 717 MW. Since the approval of the FWTP project in 2017, Oncor has confirmed that the Culberson Loop has contractually-confirmed load levels that surpass ERCOT's indicated 717 MW limit for the approved Far West Texas Project. Therefore, the endorsed FWTP project was assumed to be in-service in 2020 for the purpose of this study.

In December, 2017, Oncor submitted the Far West Texas Dynamic Reactive Devices (DRD) Project to the Regional Planning Group (RPG) to meet the summer 2019 Culberson Loop load need. The proposed DRD project was estimated to cost $86 million and was classified as Tier 1 project. At the time the DRD project was proposed, the Culberson Loop was projected to have 650 MW by 2019 and 790 MW by 2022 with the inclusion of the existing and confirmed load requests in the area.

In February, 2018, Oncor submitted the Far West Texas Project 2 (FWTP2) to address reliability requirements and ensure the transmission system in the area is able to meet the projected contractually-confirmed load level in the Culberson Loop. The proposed FWTP2 project was estimated to cost $194 million and was classified as a Tier 1 project. At the time the FWTP2 project was proposed, the Culberson Loop was projected to have 775 MW by 2019 and 1013 MW by 2022 with the inclusion of the existing and confirmed load requests in the area

As of April, 2018, Oncor has confirmed that the Culberson Loop now has contractually-confirmed load levels of 880 MW for 2019 and 1013 MW for 2022 Oncor has also indicated that additional, known *potential (not yet contractually-confirmed) load increases in the Culberson Loop may push the total to* 1339 MW

Based on the DRD and FWTP2 proposals, ERCOT completed the combined independent review for both projects together to determine the system needs for both near-term and long-term in a cost effective manner while providing flexibility to meet potential load growth in this region

Based on the forecasted loads and scenarios analyzed, ERCOT determined that there is a reliability need to improve the transmission system in Far West Texas. After consideration of several project alternatives, ERCOT concluded that the upgrades identified in Option 3 meet the reliability criteria in the most cost effective manner while providing flexibility to accommodate near-term and future load growth in the area of study Option 3 is estimated to cost $327 5 million and is described as follows

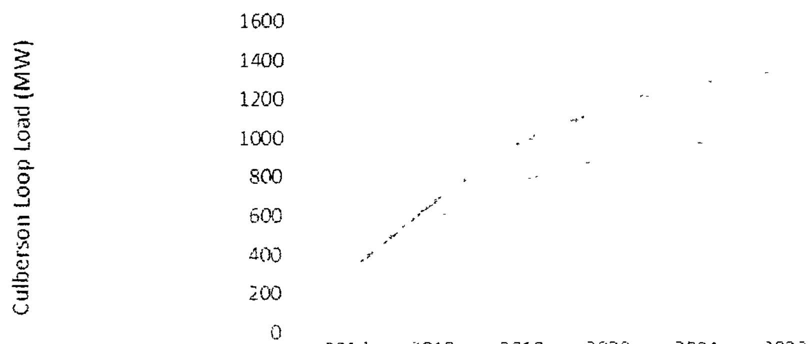
- *Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits* in place from Sand Lake Switch Station to Solstice Switch Station
- Add two new 600 MVA, 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line

- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Switch Station to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Station to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice Switch Station – Bakersfield Switch Station double circuit structures
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station.
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station

Reactive support components, including the STATCOMs and capacitors, should be implemented by 2019 if feasible to accommodate the projected 880 MW Culberson Loop demand Remedial operational schemes may be required in the Culberson Loop area to mitigate post-contingency voltage violations in the near-term until all of the recommended transmission upgrades can be put in-service to meet the Culberson Loop area load growth

2. Introduction

Over the past several years the Far West Texas Weather Zone has experienced high load growth. Between 2010 and 2016 the average annual growth rate was roughly 8%. This strong growth rate was primarily driven by increases in oil and natural gas related demand. Figure 2.1 shows the total projected load (MW) served from the Culberson Loop as indicated in the Oncor's Far West Texas Project 2 (FWTP2) RPG proposal.



	2017	2018	2019	2020	2021	2022
Confirmed Load Request	300.6	580.2	775.4	893	964 4	1013 1
Total Projected Load Additions	300.6	670.3	983 8	1163 4	1292	1339 8

Year

Figure 2.1: Total Projected Load (MW) in the Culberson Loop

Load growth along the Culberson Loop has led to several transmission improvements in the area, including the Far West Texas Project (FWTP) which was endorsed by the ERCOT Board of Directors in June, 2017. The FWTP is expected to be implemented by 2020 and will be able to serve up to 717 MW of Culberson Loop load Significant new load requests to connect to the Culberson Loop have been observed since the approval of FWTP in 2017 due to growth in the oil and gas activity As of April, 2018, the Permian Basin oil and natural gas rig count addition by county, as shown in Figure 2 2, has increased by 28% compared to April, 2017 Also, more than 70% of newly added rigs since April 2017 are located in the counties served by the Culberson Loop transmission system (Culberson, Reeves, Ward Crane, Loving, and Winkler Counties)

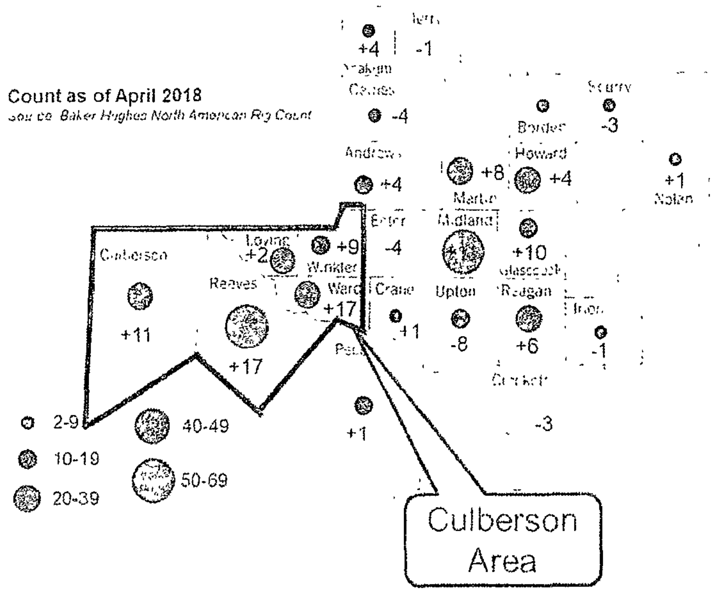


Figure 2 2 Permian Basin Oil and Natural Gas Rig Count Addition since April, 2017

In December, 2017, Oncor submitted to RPG the Far West Texas Dynamic Reactive Devices (DRD) Project, designed to meet the expected summer 2019 Culberson Loop load. The proposed DRD project was estimated to cost $86 million and was classified as a Tier 1 project. At the time of the DRD project RPG submittal, the Culberson Loop load, with the inclusion of all contractually confirmed load, was projected to be 650 MW by 2019 and 790 MW by 2022 The major components of DRD project proposal were:

- Construct a new Horseshoe Springs 138 kV Switch Station in the Riverton – Culberson 138 kV Double-circuit line
- Install two 250 MVAR, 138 kV Static Synchronous Compensators (STATCOMs) at Horseshoe Spring 138 kV Switch Station

In February, 2018, Oncor submitted the Far West Texas Project 2 (FWTP2) to address reliability requirements and ensure the transmission system in the area is able to meet the projected load. The proposed FWTP2 project was estimated to cost $194 million and was classified as a Tier 1 project. At the time the FWTP2 project was proposed, the Culberson Loop area load, again based on contractually confirmed load requests, was projected to serve 775 MW by 2019 and 1013 MW by 2022 Figure 2.3 shows the proposed FWTP2 The major components of the FWTP2 project proposal include.

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with one circuit in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA, 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)

- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Station to Riverton 138 kV Switch Station

As of April, 2018, Oncor has updated the contractually confirmed Culberson area load to be 880 MW by summer 2019 and 1013 MW by 2022 Additional load requests could potentially push the load to more than 1300 MW in the Culberson Loop.

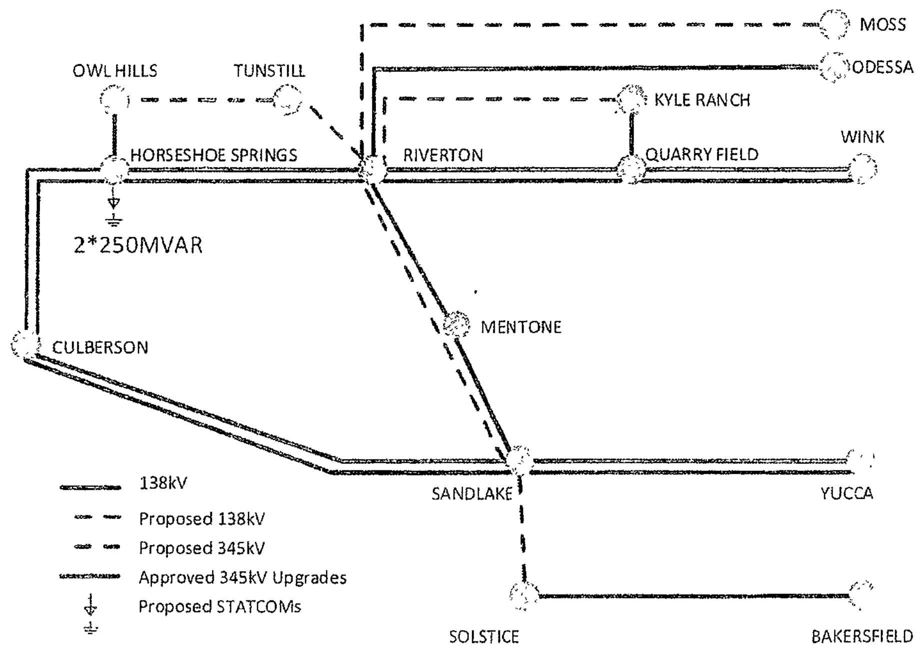


Figure 2.3: Proposed Far West Texas Project 2

Based on both the DRD and the FWTP2 proposals, ERCOT completed this independent review to determine the system needs in the Culberson Loop area and to address those needs in a cost-effective manner while providing the flexibility to meet near-term and potential long-term load growth in this area

3. Study Assumption and Methodology

ERCOT performed studies under various system conditions to evaluate the system need and identify a cost-effective solution to meet those needs in the area. The assumptions and criteria used for this review are described in this section.

3.1. Study Assumption

The primary focus of this review is the Wink – Culberson – Yucca Drive loop transmission system, referred to as the "Culberson Loop." Figure 3.1 shows the system map of the study area.

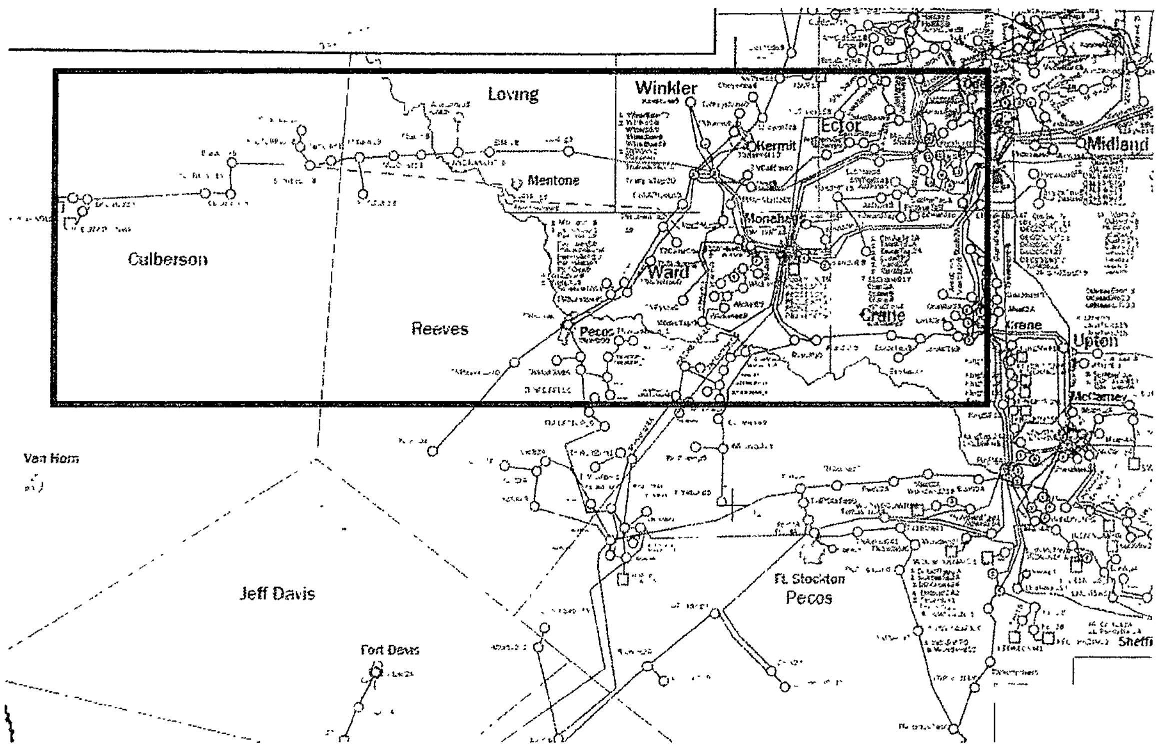


Figure 3.1: Transmission System Map of Study Area

Reliability Cases

The following starting cases were used in the study:

- The 2020 West/Far West (WFW) summer peak case from the 2017 RTP reliability case
- The 2020 Dynamics Working Group summer peak flat start case

Transmission Topology

The starting case was modified based on input from Oncor to include topological changes, switched shunt additions and load additions in the study area for both near-term 2019 summer peak and 2022 summer peak conditions

Study Case Loads and Potential Loads

Oncor provided data regarding increased load projections in the Culberson Loop area. The most recent Oncor submittal data included 880 MW for 2019 summer peak and 1030 MW for 2022 summer peak in the Culberson Loop area. Oncor met with ERCOT and shared information on the signed customer agreements which confirmed these proposed load additions.

Sensitivity cases were also created to reflect higher potential load projections from Oncor These cases contained additional customer load requests that did not yet have firm commitment at the time of this independent review. To reflect this "Potential" load growth, the load was increased by 334 MW in the Culberson Loop for 2022 summer peak The total load in the Potential Load Case was approximately 1347 MW in the Culberson Loop for the Potential Load sensitivity.

Generation

Planned generators in the Far West and West Weather Zones that met Planning Guide Section 6.9 conditions for inclusion in the base cases (according to the 2016 October Generation Interconnection Status report), which were not included in the RTP cases, were added. The added generators are listed in Table 3.1.

Table 3.1 Added Generators That Met Planning Guide Section 6.9 Conditions (2018 April GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
14INR0044	West of Pecos Solar	100	Solar	Reeves	Far West

Key assumptions applied in this study include the following

- Wind generation in West and Far West weather zones were set to have a maximum dispatch capability of 2 6% of their rated capacity. This assumption was in accordance with the 2016 Regional Transmission Plan Study Scope and Process document[1]
- Solar generation was set at 70% of their rated capacity in accordance with the 2016 Regional Transmission Plan Study Scope and Process document
- Considering the oil and gas industry load characteristics (flat load), the most stressed system condition is during the night when solar generation is not available. To study this condition, no solar generation was dispatched in the study base conditions.

Capital Cost Estimates

Capital cost estimates for transmission facilities were provided by Oncor, AEPSC and LCRA TSC. These costs were provided for individual transmission facilities and ERCOT used those values to calculate total project costs for various project options

3.2. Criteria for Violations

The following criteria were used to identify planning criteria violations

All 100 kV and above busses, transmission lines, and transformers in the study region were monitored (excluding generator step-up transformers).

- Thermal criteria violations
    - Rate A for Normal Conditions

[1] http://www.ercot.com/content/wcm/key_documents_lists/77730/2016_RTP_Scope_Process_v1 3_clean pdf

  - Rate B for Emergency Conditions
- Voltage violation criteria
  - 0.95 < V pu < 1.05 Normal
  - 0.90 < V pu < 1.05 Emergency
  - Post Contingency voltage deviations
    - 8% on non-radial load buses
- Dynamic Stability Analysis
  - NERC TPL-001-4 and ERCOT Planning Guide Section 4

3.3. Study Tools

ERCOT utilized the following software tools for the independent review of the Far West Texas Project:

- PSS/e version 33 was used to perform the dynamic stability analysis and in the initial steady-state case creation to incorporate the TSP idvs files
- PowerWorld Simulator version 20 for SCOPF and steady state contingency analysis
- VSAT version 17 was used for voltage stability analysis
- UPLAN version 10.2.0.19928

4. Project Need

The need for a transmission improvement project was evaluated for the Study Case. Table 4.1 summarized the steady state voltage stability (Power-Voltage) assessment results for the 2019 summer peak. The results showed pre-contingency voltage stability issues with no transmission upgrades. Even with the addition of the ERCOT Board of Directors approved Far West Texas Project (FWTP), as shown in Table 4.1 Scenario 2, the results indicated both voltage violations and voltage collapse under certain contingencies for the projected Culberson Loop 2019 summer peak load. The project need analysis results are consistent with the finding of the 2017 FWTP ERCOT independent review that identified the need for additional upgrades (beyond the FWTP project endorsed in June 2017) to serve loads greater that 717 MW in the Culberson Loop.

Table 4.1 Steady State Voltage Stability Assessment for the Base Case Condition

Scenario	Load (MW)	Transmission Upgrades	Culberson Load Serving Capability	
			NERC P1, P7	NERC P6
1	880 (2019 Summer Peak)	None	Pre-contingency Voltage Collapse	
2.	880 (2019 Summer Peak)	FWTP(1)	Voltage Violation Voltage Collapse	Voltage Violation Voltage Collapse

(1) The Far West Texas Project (FWTP) endorsed by ERCOT Board of Directors in June, 2017

5. Project Options

5.1. Options Considerations

The FWTP, which was endorsed by the ERCOT Board of Directors in June 2017, was designed to allow for a number of different expansion options that could accommodate additional load growth. All project alternatives considered in this study align with the expansion options evaluated as part of the ERCOT FWTP independent review.

In addition, project options considered in this study were limited to alternatives that included adding a second 345 kV circuit to the Odessa EHV – Riverton (between Moss and Riverton) and Solstice – Bakersfield 345 kV lines This limitation was result of the following considerations:

- The Culberson Loop area has experienced a significant rate of load growth. This evaluation focused on contractually committed load with a sensitivity evaluation which includes new customers that have contacted the TSPs with load requests but have not yet finalized a contract to construct. However, it is possible that more, presently unknown, load requests will materialize before the facilities recommended in this evaluation are in service.
- The Odessa EHV – Riverton and Solstice – Bakersfield 345 kV lines have yet to be constructed. If they were constructed with one circuit in place and a second 345 kV circuit was later deemed necessary, the construction outage to add the second circuit would greatly reduce the load serving capability to the Culberson Loop and reduce the operational flexibility during what would likely be a long duration outage.
- It is approximately 50% less expensive to construct the two circuits in place at the initial build than the cost of coming back to install the second circuit at a later time due to reduced access, environmental and mobilization costs, and construction efficiencies

In addition, the new 138 kV lines proposed in the FWTP2 project are necessary to strengthen the Culberson Loop and provide operational flexibility under normal and outage conditions.

5.2. Short-Listed Options

Based on the considerations listed above and the results of preliminary analysis, the following "universal" transmission upgrades were included in all of the short-listed options

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station

- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice Switch Station – Bakersfield Switch Station double circuit structures

The following three options were studied further for the reactive support in the Culberson Loop. The detailed description of the three short-listed options are provided below and diagrams for these are included in the Appendix.

Option **1**

- Universal transmission upgrades
- Install two 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station

The total cost estimate for Option 1 is approximately $300.0 Million.

Option **2**

- Universal transmission upgrades
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Horseshoe Springs 138 kV Switch Station.
- Install capacitor banks with a total capacity of 150 MVAR at Quarry Field 138 kV Switch Station

The total cost estimate for Option 2 is approximately $292.5 Million.

Option **3**

- Universal transmission upgrades
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Quarry Field 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Horseshoe Springs 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Quarry Field 138 kV Switch Station

The total cost estimate for Option 3 is approximately $327 5 Million

6. Voltage Stability and Dynamic Stability Analysis

A Power-Voltage (PV) analysis was used in the steady state voltage stability assessment for the Culberson Loop area for all short-listed options for the studied scenarios. A Power-Voltage (PV) analysis was used to proportionally increase the load in the Culberson Loop until a voltage collapse identified the maximum load serving capability for the options. Table 7.1 shows the results of this analysis, indicating the maximum loads in the Culberson Loop area that can be reliably served by the three identified project options. A sensitivity analysis was conducted to evaluate the impact of nearby generators to the Culberson Loop load serving capability. All five generators at the Permian Basin (PBSES) generation station were off-line in the study case The PV results are in listed in Table 7.1.

Table 7.1 Voltage and Dynamic Stability Assessment of All Options for Culberson Loop Load Serving Capability

	Culberson Loop Load Served (MW)		
Description	Option 1	Option 2	Option 3
PV Voltage Collapse Results (NERC P1, P6 P7, ERCOT Events)	1608	1568	1688
PV Voltage Collapse Results (without PBSES Units) (NERC P1, P6, P7, ERCOT Events)	1508	1468	1648
Dynamic Stability Result (without PBSES Units) (NERC P1, P6, P7, ERCOT Events)[1]	Acceptable	Acceptable	Acceptable
Estimated Capital Cost ($M)	300	292 5	327 5

(1). Dynamic stability was conducted at the Culberson Loop load level identified in the PV voltage collapse results

The majority of the loads in the study area were assumed to be oil and gas customers who employ voltage-sensitive electric equipment in their operations As specified by Oncor, heavy motor load was assumed to represent the load characteristic in the study area. All three options were tested using time domain dynamic stability simulations including a dynamic load model provided by Oncor to evaluate system stability

It was assumed that if simulations indicated an acceptable (stable) system response following severe events and/or three-phase faults the stability response would also be acceptable for the same events with a single-line-to-ground (SLG) fault If a potential stability issue was observed, the simulation was rerun with SLG faults to ensure a stable system response following a NERC planning event In this way the analysis demonstrated compliance with NERC planning standards and ERCOT reliability criteria In these simulations, selected ERCOT transmission buses were monitored for angle and voltage responses.

The dynamic event definitions included the removal of all elements that the protection system and other automatic controls are expected to disconnect for each event. The dynamic simulation results are also listed in Table 7 1

None of the three options will be fully in-service prior to summer 2019, when the load is projected to reach 880 MW, since the new transmission lines will not be constructed As a result, a PV analysis was conducted for the 2019 summer condition assuming only the reactive devices in all three options can be implemented to support the Culberson Loop in 2019 The PV analysis results are listed in Table 7 2 The results indicate that for Options 1 and 2 additional operational mitigation measures will be needed to maintain reliability prior to the new transmission lines being put in place These operational mitigation measures may include (but are not limited to) undervoltage load shed

Table 7.2 Steady State Voltage Stability Assessment of All Options for Culberson Loop Load Serving Capability with Reactive Devices Only

	Culberson Loop Load Served (MW)		
Description	Option 1	Option 2	Option 3
PV Voltage Collapse Results (reactive devices only[1]) (NERC P1, P6, P7, ERCOT Events)	801	821	1001
PV Voltage Collapse Results (without PBSES units) (reactive devices only[1]) (NERC P1, P6, P7, ERCOT Events)	721	741	880[2]

(1). Assuming reactive devices will be in service before new transmission lines.

(2) Oncor indicated that the reactive devices identified to be located at Quarry Field 138 kV Switch Station may not be in service by summer 2019 ERCOT performed a PV analysis considering only the reactive devices located at Horseshoe Springs from Option 3 The results showed that without the Quarry Field reactive devices in service, Option 3 would have a load serving capability of 721 MW.

7. Economic Analysis

Although this RPG project is driven by reliability needs, ERCOT also conducted an economic analysis to identify any potential impact on system congestion related to the addition of the transmission upgrades

The base case for this economic analysis used the 2023 economic case built for the 2017 RTP as the starting case. The topology changes and generation additions were similar to the steady state base case built. ERCOT modeled each of the three short-listed options and performed production cost simulations for the year 2023. The annual production analysis showed no measurable congestion impact on the ERCOT System with the addition of the transmission upgrades.

8. Subsynchronous Resonance (SSR) Vulnerability Assessment

According to Protocol Section 3.22.1 3(2), ERCOT performed a SSR vulnerability assessment using topology check and the results indicated that all three short-listed options strengthen the transmission network and increase the required transmission circuit outages to have a Generation Resource become radial to series capacitors. The SSR assessment results showed no SSR vulnerability for any existing Generation Resources or Generation Resources satisfying Planning Guide Section 6.9 conditions for inclusion in the planning models at the time of this study.

9. Final Options Comparison

As shown in Table 9.1. a comparison of study results for the three options shows that Option 3, shown in Figure 9 1, met the system reliability criteria under the studied load conditions while providing better load serving capability to accommodate both the near-term and potential future load needs in the Culberson Loop area.

Table 9.1 Options Comparison

Description	Option 1	Option 2	Option 3
Capital cost ($ Million)	300.0	292.5	327.5
PV Results, Culberson Load Served	1608	1568	1688
PV Results, Culberson Load Served (with only reactive support devices recommended in the options)	801	821	1001
PV Results, Culberson Load Served (without PBSES Units)	1508	1468	1648
PV Results, Culberson Load Served (without PBSES Units) (with only reactive support devices recommended in the options)	721	741	880
Dynamic Stability Results. Culberson Load Served	Acceptable	Acceptable	Acceptable

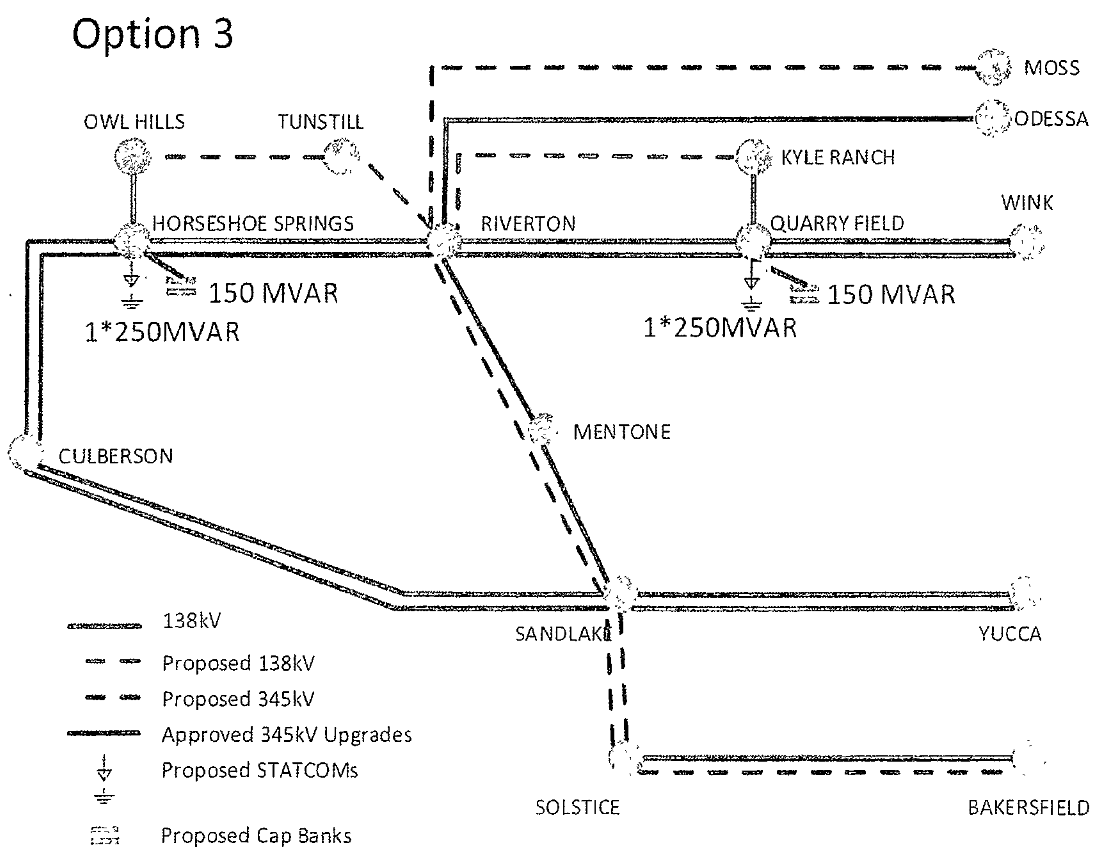


Figure 9.1· Option 3

10. Sensitivity Studies

Sensitivity studies were performed to ensure compliance with Planning Guide requirements.

10.1. Generation Sensitivity Analysis

According to Planning Guide Section 3.1.3(4)(a), the generation sensitivity analysis will evaluate the effect that proposed Generation Resources in or near the study area will have on a recommended transmission project. Based on the 2018 April Generator Interconnection Status report, Table 10.1 1 shows all the generators in the area that met Planning Guide 6.9 and Table 10.1.2 shows all the generators in the area with a signed standard generator interconnection agreement (SGIA) that did not meet Planning Guide 6.9 conditions for inclusion in the planning models. Considering the oil and gas industry load characteristics, the most stressed system condition is during the night when solar generation is not available. No solar generation in the Culberson Loop was assumed available in the study base conditions. Therefore, the proposed Generation Resources in the Culberson Loop area will have no impact on the recommended transmission project.

Table 10.1.1 Generators Met Planning Guide Section 6.9 Conditions (2017 March GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
14INR0044	West of Pecos Solar	100	Solar	Reeves	Far West

Table 10.1.2 Generators with SGIA That Did Not Meet Planning Guide Section 6.9 Conditions (2017 March GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
18INR0022	Winkler Solar	150	Solar	Winkler	Far West

10.2. Load Scaling Impact Analysis

Planning Guide Section 3.1 3(4) (b) requires evaluation of the impact of various load scaling on the criteria violations seen in the study cases.

Because the voltage violations were observed at load serving buses inside the Culberson Loop, ERCOT assumed that the load scaling in the outside weather zones did not have a material impact on the observed need.

11. Conclusion

Based on the forecasted loads and scenarios analyzed, ERCOT determined that there is a reliability need to improve the transmission system in Far West Texas. After consideration of the project alternatives, ERCOT concluded that the upgrades identified in Option 3 meet the reliability criteria in the most cost effective manner and provide needed load serving capability to the rapid oil and gas industry load growth in the Culberson Loop area Option 3 is estimated to cost $327.5 million and is described as follows:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA, 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice 345 kV Switch Station – Bakersfield 345 kV Switch Station double circuit structures
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station

The reactive support components, including STATCOMs and capacitors, recommended in Option 3 should be implemented by 2019 if feasible to accommodate the projected 880 MW Culberson Loop in summer 2019. Additionally, the sizing of capacitor bank stages should take into account operational considerations Remedial operational schemes may be required to mitigate post-contingency voltage violations in the Culberson Loop area until the recommended transmission upgrades can be built to reliably serve the increasing load.

12. Designated Provider of Transmission Facilities

In accordance with the ERCOT Nodal Protocols Section 3.11.4.8, ERCOT staff is to designate transmission providers for projects reviewed in the RPG. The default providers will be those that own the end points of the new projects. These providers can agree to provide or delegate the new facilities or inform ERCOT if they do not elect to provide them. If different providers own the two ends of the recommended projects, ERCOT will designate them as co-providers and they can decide between themselves what parts of the recommended projects they will each provide.

Oncor owns the Odessa EHV Switch Station, Moss Switch Station and is planning to construct and own the new Riverton Switching Station and therefore is the presumed owner of the Riverton Switching Station. Therefore, ERCOT designates Oncor as the designated provider for the 345 kV Odessa EHV to Riverton and Moss to Riverton transmission facilities along with the two recommended 345/138 kV autotransformers at Riverton.

LCRA TSC owns the Bakersfield Switchyard while AEPSC is constructing and planning to own the new Solstice Substation and therefore is the presumed owner of the Solstice Substation. Therefore. ERCOT designates AEPSC and LCRA TSC as the designated co-providers for the 345 kV Bakersfield to Solstice transmission facilities but AEPSC as the provider of the two recommended 345/138 kV autotransformers at Solstice

Oncor is planning to construct and own the new Sand Lake Switching Station and therefore is the presumed owner of the Sand Lake Switching Station, while AEPSC is constructing and planning to own the new Solstice Substation and therefore is the presumed owner of the Solstice Substation ERCOT designates Oncor and AEPSC as the designated co-providers for the 345 kV Sand Lake to Solstice transmission facilities and Oncor as the provider of the two recommended 345/138 kV autotransformers at Sand Lake Switch Station

Oncor owns all the 138 kV Switch Stations listed in the recommended Option 3 Therefore, ERCOT designates Oncor as the designated provider for all the 138 kV transmission facilities along with the proposed STATCOMs and static capacitor banks

The designated TSPs have requested critical designation status for the Riverton – Sand Lake 345 kV Line. the Sand Lake – Solstice 345 kV Line. and the Bakersfield – Solstice 345 kV line for multiple operational and reliability needs to address the rapid load growth in the Culberson Loop area ERCOT designates the project critical to reliability per PUCT Substantive Rule 25 101(b)(3)(D)

13. Appendix

Options Diagrams	Options_OneLine.pptx

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ELECTRIC RELIABILITY COUNCIL OF TEXAS, INC.
BOARD OF DIRECTORS RESOLUTION

WHEREAS, after due consideration of the alternatives, the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) deems it desirable and in the best interest of ERCOT to accept ERCOT staff's recommendation to (1) endorse the need for the Far West Regional Planning Group (RPG) Projects (Option 3), which ERCOT staff has independently reviewed and which the Technical Advisory Committee (TAC) has voted unanimously to endorse, based on North American Electric Reliability Corporation (NERC) and ERCOT planning reliability criteria, and (2) designate the Riverton-Sand Lake, Sand Lake-Solstice, and Solstice-Bakersfield 345 kV lines as critical to the reliability of the ERCOT System pursuant to Public Utility Commission of Texas (PUCT) Substantive Rule 25.101(b)(3)(D);

THEREFORE, BE IT RESOLVED, that the ERCOT Board hereby (1) endorses the need for the Far West RPG Projects (Option 3), which ERCOT staff has independently reviewed and which TAC has voted unanimously to endorse, based on NERC and ERCOT planning reliability criteria, and (2) designates the Riverton-Sand Lake, Sand Lake-Solstice, and Solstice-Bakersfield 345 kV lines as critical to the reliability of the ERCOT System pursuant to PUCT Substantive Rule 25.101(b)(3)(D).

CORPORATE SECRETARY'S CERTIFICATE

I, Vickie G. Leady, Assistant Corporate Secretary of ERCOT, do hereby certify that, at its June 12, 2018 meeting, the ERCOT Board passed a motion approving the above Resolution by unanimous voice vote with no abstentions.

IN WITNESS WHEREOF, I have hereunto set my hand this 12th day of June, 2018.

Vickie G. Leady

Vickie G. Leady
Assistant Corporate Secretary

Document Revisions

Date	Version	Description	Author(s)
05/21/201[illegible]	1.0	Final Report	Xiaoyu Wang, Ying Li, Priya Ramasubbu
		Reviewed by	Prabhu Gnanam, Shun Hsien (Fred) Huang, Jeff Billo

Table of Contents

1. Executive Summary

In June 2017, the ERCOT Board of Directors endorsed the Far West Texas Project (FWTP), a Tier 1 transmission project to address the transmission needs both in the Culberson Loop area and the Barilla Junction area that could reliably serve the Culberson Loop load up to 717 MW. Since the approval of the FWTP project in 2017, Oncor has confirmed that the Culberson Loop has contractually-confirmed load levels that surpass ERCOT's indicated 717 MW limit for the approved Far West Texas Project. Therefore, the endorsed FWTP project was assumed to be in-service in 2020 for the purpose of this study.

In December, 2017, Oncor submitted the Far West Texas Dynamic Reactive Devices (DRD) Project to the Regional Planning Group (RPG) to meet the summer 2019 Culberson Loop load need. The proposed DRD project was estimated to cost $86 million and was classified as Tier 1 project. At the time the DRD project was proposed, the Culberson Loop was projected to have 650 MW by 2019 and 790 MW by 2022 with the inclusion of the existing and confirmed load requests in the area.

In February, 2018, Oncor submitted the Far West Texas Project 2 (FWTP2) to address reliability requirements and ensure the transmission system in the area is able to meet the projected contractually-confirmed load level in the Culberson Loop. The proposed FWTP2 project was estimated to cost $184 million and was classified as a Tier 1 project. At the time the FWTP2 project was proposed, the Culberson Loop was projected to have 775 MW by 2019 and 1013 MW by 2022 with the inclusion of the existing and confirmed load requests in the area.

As of April, 2018, Oncor has confirmed that the Culberson Loop now has contractually-confirmed load levels of 890 MW for 2019 and 1013 MW for 2022. Oncor has also indicated that additional, known potential (not yet contractually-confirmed) load increases in the Culberson Loop may push the total to 1339 MW.

Based on the DRD and FWTP2 proposals, ERCOT completed the combined independent review for both projects together to determine the system needs for both near-term and long-term in a cost-effective manner while providing flexibility to meet potential load growth in this region.

Based on the forecasted loads and scenarios analyzed, ERCOT determined that there is a reliability need to improve the transmission system in Far West Texas. After consideration of several project alternatives, ERCOT concluded that the upgrades identified in Option 3 meet the reliability criteria in the most cost-effective manner while providing flexibility to accommodate near-term and future load growth in the area. [illegible] Option 3 has an estimated total cost of $[illegible] million and is described as follows:

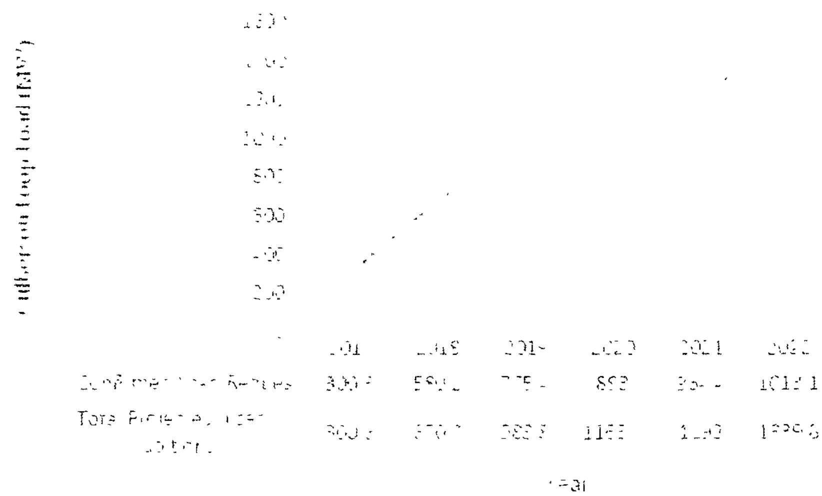
- Construct a new approximately [illegible] mile 345-kV line on double-circuit structures with one circuit in place from Sand Lake Switch Station to Solstice Switch Station
- Add two new 600 MVA 345/138-kV autotransformers at Sand Lake 345-kV Switch Station
- Install a new 345-kV circuit on the [illegible] Riverton – Sand Lake double circuit structures
- Install the second 345-kV circuit on the Odessa EHV – Riverton 345-kV line double circuit structures between Moss and [illegible] Riverton 345-kV circuit
- Construct a new Quarry Field [illegible] Riverton double circuit [illegible] line

- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Switch Station to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill - Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Station to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice Switch Station – Bakersfield Switch Station double circuit structures
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station

Reactive support components, including the STATCOMs and capacitors, should be implemented by 2019 if feasible to accommodate the projected 880 MW Culberson Loop demand Remedial operational schemes may be required in the Culberson Loop area to mitigate post-contingency voltage violations in the near-term until all of the recommended transmission upgrades can be put in-service to meet the Culberson Loop area load growth

2 [illegible]

Over the past several years the Far West Texas Weather Zone has experienced high load growth. Between 2010 and 2018 the average annual growth rate was roughly 8%. This strong growth rate was primarily driven by increases in oil and natural gas related demand. Figure 2.1 shows the [illegible] projected load (MW) served from the Culberson Loop as indicated in the Oncor's Far West Texas Project 2 (FWTP2) RPG proposal.



[illegible] the Culberson Loop

Load growth along the Culberson Loop has led to several transmission improvements in the area including the Far West Texas Project (FWTP) which was endorsed by the ERCOT Board of Directors in June, 2017. The FWTP is expected to be implemented by 2020 and will be able to serve up to 717 MW of Culberson Loop load. Significant new load requests to connect to the Culberson Loop have been observed since the approval of FWTP in 2017 due to growth in the oil and gas activity. As of April 2018, the Permian Basin oil and natural gas rig count [illegible] by county (as shown in Figure 2.2) has increased by 28% compared to April 2017. Also, more than 7[illegible]% of newly added rigs since April 2017 are located in the counties served by the Culberson Loop transmission system (Culberson, Reeves, Ward, Crane, Loving and Winkler Counties).

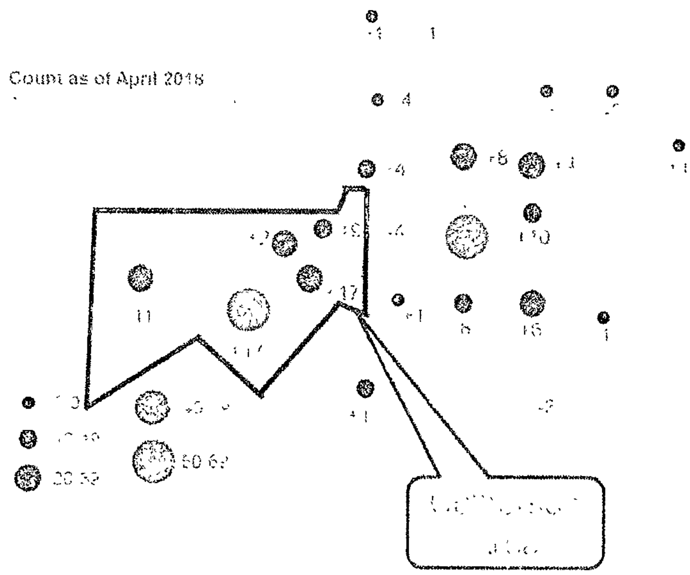


Figure 2.2 Permian Basin Oil and Natural Gas Rig Count Addition since April, 2017

In December, 2017, Oncor submitted to RPG the Far West Texas Dynamic Reactive Devices (DRD) Project designed to meet the expected summer 2019 Culberson Loop load. The proposed DRD project was estimated to cost $86 million and was classified as a Tier 1 project. At the time of the DRD project RPG submittal, the Culberson Loop load, with the inclusion of all contractually confirmed load, was projected to be 650 MW by 2019 and 790 MW by 2022. The major components of DRD project proposal were

- Construct a new Horseshoe Springs 138 kV Switch Station in the Riverton – Culberson 138 kV Double-circuit line
- Install two 250 MVAR, 138 kV Static Synchronous Compensators (STATCOMs) at Horseshoe Spring 138 kV Switch Station

In February, 2018, Oncor submitted the Far West Texas Project 2 (FWTP2) to address reliability requirements and ensure the transmission system in the area is able to meet the projected load. The proposed FWTP 2 project was estimated to cost $18[illegible] million and was classified as a Tier 1 project. At the time the FWTP2 project was proposed, the Culberson Loop area load, again based on contractually confirmed load requests, was projected to serve 775 MW by 2019 and 1013 MW by 2022. Figure 2.3 shows the proposed FWTP2. The major components of the FWTP2 project proposal include:

- Construct a new approximately 40-mile 345 kV line on double circuit structures with one circuit in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)

- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Station to Riverton 138 kV Switch Station

As of April, 2018, Oncor has updated the contractually confirmed Culberson area load to be 380 MW by summer 2019 and 1013 MW by 2022. Additional load requests could potentially push the load to more than 1300 MW in the Culberson Loop.

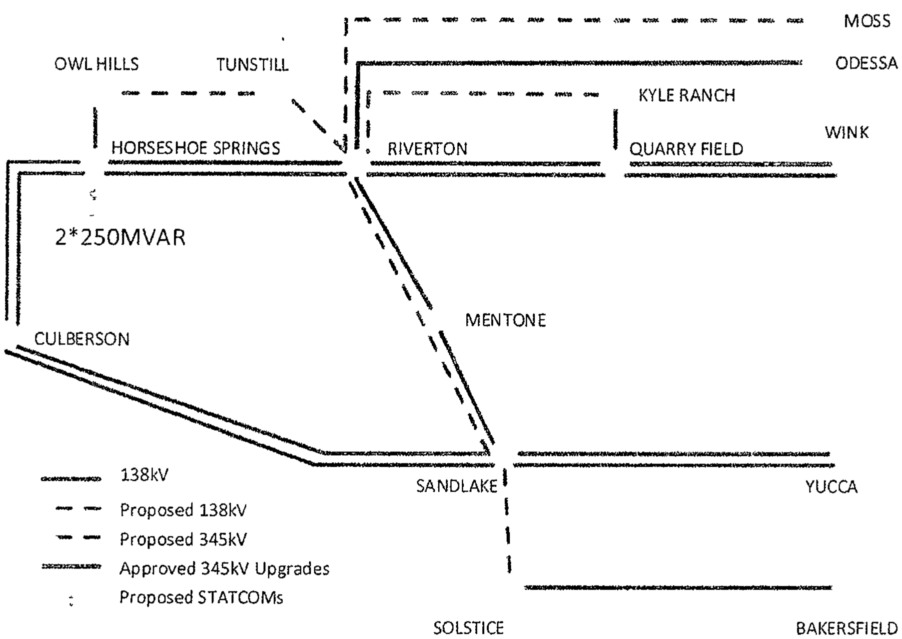


Figure 2.3: Proposed Far West Texas Project 2

Based on both the DRD and the FWTP2 proposals, ERCOT completed this independent review to determine the system needs in the Culberson Loop area and to address those needs in a cost-effective manner while providing the flexibility to meet near-term and potential long-term load growth in this area.

3. Study Assumption and Methodology

ERCOT performed studies under various system conditions to evaluate the system need and identify a cost-effective solution to meet those needs in the area. The assumptions and criteria used for this review are described in this section.

3.1. Study Assumption

The primary focus of this review is the Wink – Culberson – Yucca Drive loop transmission system referred to as the "Culberson Loop." Figure 3.1 shows the system map of the study area.

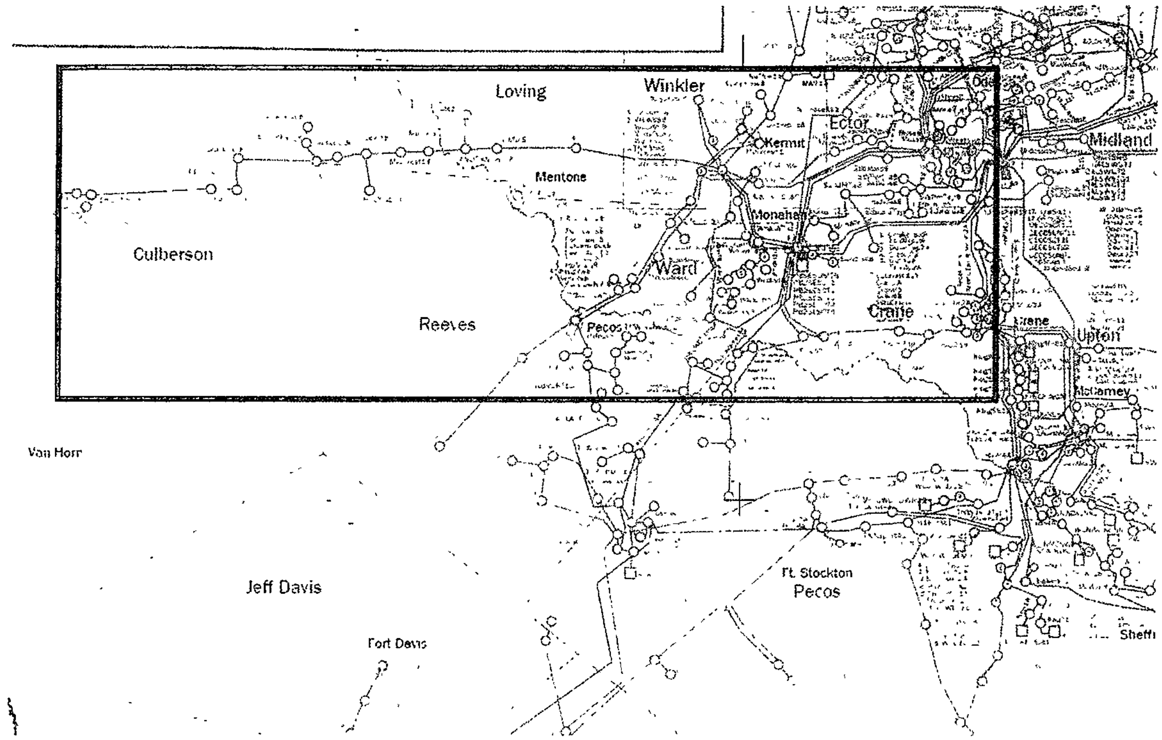


Figure 3.1 [illegible] System Map of Study Area

Reliability Cases

The following starting cases were used in the study:

- The 2020 West/Far West (WFW) summer peak case from the 2017 RTP reliability case
- The 2020 Dynamics Working Group summer peak flat start case

Transmission Topology

The starting case was modified based on input from Oncor to include topological changes, switched shunt additions and load additions in the study area for both near-term 2018 summer peak and 2022 summer peak conditions.

Study Case Loads and Potential Loads

Oncor provided data regarding increased load projections in the Culberson Loop area. The most recent Oncor submittal data included [illegible]50 MW for 2018 summer peak and 1030 MW for 2022 summer peak in the Culberson Loop area. Oncor met with ERCOT and shared information on the signed customer agreements which confirmed these proposed load additions.

Sensitivity cases were also created to reveal higher potential load projections from Oncor. These cases contained additional customer load requests that did not yet have a firm commitment at the time of this independent review. To reflect this Potential load growth, the load was increased by 33[illegible] MW in the Culberson Loop for 2022 summer peak. The total load in the Potential Load Case was approximately 1347 MW in the Culberson Loop for the Potential Load sensitivity.

Generation

Planned generators in the Far West and West Weather Zones that met Planning Guide Section 6.9 conditions for inclusion in the base cases (according to the 2016 October Generation Interconnection Status report) which were not included in the RTP cases, were added. The added generators are listed in Table 3.1.

Table 3.1 Added Generators That Met Planning Guide Section 6.9 Conditions (2016 April GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
14INR0044	West of Pecos Solar	100	Solar	Reeves	Far West

Key assumptions applied in this study include the following:

- Wind generation in West and Far West weather zones were set to have a maximum dispatch capability of 2.6% of their rated capacity. This assumption was in accordance with the 2016 Regional Transmission Plan Study Scope and Process document.[1]
- Solar generation was set at 70% of their rated capacity in accordance with the 2016 Regional Transmission Plan Study Scope and Process document.
- Considering the oil and gas industry load characteristics (flat load), the most stressed system condition is during the night when solar generation is not available. To study this condition, no solar generation was dispatched in the study base conditions.

Project Cost Estimates

Capital cost estimates for transmission facilities were provided by Oncor, AEP SC and LCRA TSC. These costs were provided for individual transmission facilities and ERCOT used those values to calculate total project costs for various project options.

3.2 Criteria for Violations

The following criteria were used to identify planning criteria violations:

All 100 kV and above busses, transmission lines, and transformers in the study region were monitored (excluding generator step-up transformers).

Thermal criteria violations

- Rate A for normal conditions

[1] http://www.ercot.com/content/wcm/key_documents_lists/77730/2016_RTP_Scope_Process_v1.3_clean.pdf

  - Rate B for Emergency Conditions
- Voltage violation criteria
  - $0.95 < V_{pu} < 1.05$ Normal
  - $0.90 < V_{pu} < 1.05$ Emergency
  - Post Contingency voltage deviations
    - 8% on non-radial load buses
- Dynamic Stability Analysis
  - NERC TPL-001-4 and ERCOT Planning Guide Section 4

3.3. Study Tools

ERCOT utilized the following software tools for the independent review of the Far West Texas Project

- PSS/e version 33 was used to perform the dynamic stability analysis and in the initial steady-state case creation to incorporate the TSP idvs files
- PowerWorld Simulator version 20 for SCOPF and steady state contingency analysis
- VSAT version 17 was used for voltage stability analysis
- UPLAN version 10 2 0 19928

4. Project Need

The need for a transmission improvement project was evaluated for the Study Case. Table 4.1 summarized the steady state voltage stability (Power-Voltage) assessment results for the 2019 summer peak. The results showed pre-contingency voltage stability issues with no transmission upgrades. Even with the addition of the ERCOT Board of Directors approved Far West Texas Project (FWTP) as shown in Table 4.1 Scenario 2, the results indicated both voltage violations and voltage collapse under certain contingencies for the projected Culberson Loop 2019 summer peak load. The project need analysis results are consistent with the finding of the 2017 FWTP ERCOT independent review that identified the need for additional upgrades (beyond the FWTP project endorsed in June 2017) to serve loads greater than 717 MW in the Culberson Loop.

Table 4.1 Steady state Voltage Stability Assessment for the Base Case Condition

Scenario	Load (MW)	Transmission Upgrades	Culberson Load Serving Capability	
			NERC P1, P7	NERC P6
1	880 (2019 Summer Peak)	None	Pre-contingency Voltage Collapse	
2	880 (2019 Summer Peak)	FWTP	Voltage Violation Voltage Collapse	Voltage Violation Voltage Collapse

(1) The Far West Texas Project (FWTP) endorsed by ERCOT Board of Directors in June, 2017

5 Project Options

5.1 Options Considerations

The FWTP, which was endorsed by the ERCOT Board of Directors in June 2017, was designed to allow for a number of different expansion options that could accommodate additional load growth. All project alternatives considered in this study align with the expansion options evaluated as part of the ERCOT FWTP independent review.

In addition, project options considered in this study were limited to alternatives that included adding a second 345 kV circuit to the Odessa EHV – Riverton (between Moss and Riverton) and Solstice – Bakersfield 345 kV lines. This limitation was result of the following considerations:

- The Culberson Loop area has experienced a significant rate of load growth. This evaluation focused on contractually committed load with a sensitivity evaluation which includes new customers that have contacted the TSPs with load requests but have not yet finalized a contract to construct. However, it is possible that more, presently unknown, load requests will materialize before the facilities recommended in this evaluation are in service.
- The Odessa EHV – Riverton and Solstice – Bakersfield 345 kV lines have yet to be constructed. If they were constructed with one circuit in place and a second 345 kV circuit was later deemed necessary, the construction outage to add the second circuit would greatly reduce the load serving capability to the Culberson Loop and reduce the operational flexibility during what would likely be a long duration outage.
- It is approximately 50% less expensive to construct the two circuits in place at the initial build than the cost of coming back to install the second circuit at a later time due to reduced access, environmental and mobilization costs, and construction efficiencies.

In addition, the new 138 kV lines proposed in the FWTP2 project are necessary to strengthen the Culberson Loop and provide operational flexibility under normal and outage conditions.

5.2 Short-Listed Options

Based on the considerations listed above and the results of preliminary analysis, the following "universal" transmission upgrades were included in all of the short-listed options:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with two circuits in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile [illegible] Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from [illegible] Ranch 138 kV Substation to Riverton 138 kV Switch Station

- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice Switch Station – Bakersfield Switch Station double circuit structures

The following three options were studied further for the reactive support in the Culberson Loop. The detailed description of the three short-listed options are provided below and diagrams for these are included in the Appendix

Option 1

- Universal transmission upgrades
- Install two 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station

The total cost estimate for Option 1 is approximately $300 0 Million

Option 2

- Universal transmission upgrades
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Horseshoe Springs 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Quarry Field 138 kV Switch Station

The total cost estimate for Option 2 is approximately $292 5 Million

Option 3

- Universal transmission upgrades
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR Static Synchronous Compensators (STATCOMs) at Quarry Field 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Horseshoe Springs 138 kV Switch Station
- Install capacitor banks with a total capacity of 150 MVAR at Quarry Field 138 kV Switch Station

The total cost estimate for Option 3 is approximately $327 5 Million

6. Voltage Stability and Dynamic Stability Analysis

A Power-Voltage (PV) analysis was used in the steady state voltage stability assessment for the Culberson Loop area for all short listed options for the studied scenarios. A Power-Voltage (PV) analysis was used to proportionally increase the load in the Culberson Loop until a voltage collapse identified the maximum load serving capability for the options. Table 7.1 shows the results of this analysis indicating the maximum loads in the Culberson Loop area that can be reliably served by the three identified project options. A sensitivity analysis was conducted to evaluate the impact of nearby generators to the Culberson Loop load serving capability [illegible] generators at the Permian Basin (PBSES) generation station were off-line in the study case. The PV results are also listed in Table 7.1.

Table 7.1 Voltage and Dynamic Stability Results [illegible] Culberson Loop Load Serving Capability

	Culberson Loop Load Served (MW)		
Description	Option 1	Option 2	Option 3
PV Voltage Collapse Results (NERC P1, P6, P7, ERCOT Events)	1308	1568	1588
PV Voltage Collapse Results (without PBSES Units) (NERC P1, P6, P7, ERCOT Events)	1508	1438	1548
Dynamic Stability Result (without PBSES Units) (NERC P1, P6, P7, ERCOT Events) [1]	Acceptable	Acceptable	Acceptable
Estimated Capital Cost ($M)	300	292.5	327.5

(1) Dynamic stability was conducted at the Culberson Loop load level identified in the PV voltage collapse results

The majority of the loads in the study area were assumed to be oil and gas customers who employ voltage sensitive electric equipment in their operations. As specified by Oncor, heavy motor load was assumed to represent the load characteristic in the study area. All three options were tested using time domain dynamic stability simulations including a dynamic load model provided by Oncor to evaluate system stability.

It was assumed that if simulations indicated an acceptable (stable) system response during severe events and/or three-phase faults, the stability response would also be acceptable for the same events with a single-line-to-ground (SLG) fault. If a potential stability issue was observed, the simulation was rerun with SLG faults to ensure a stable system response following a NERC planning event. In this way the analysis demonstrated compliance with NERC planning standards and ERCOT reliability criteria. In these simulations [illegible] ERCOT [illegible] criteria [illegible] voltage responses.

The dynamic event definitions [illegible] removal of all elements [illegible] and [illegible] automatic controls are expected to disconnect for each event. The dynamic stability results are also listed in Table 7.1.

None of the three options will be fully in service prior to summer 2019, when the load is projected to reach 830 MW, since the new transmission lines will not be constructed [illegible] PV analysis was conducted for the 2019 summer condition assuming only the [illegible] of the three options can be implemented to support the Culberson Loop in 2019. The PV analysis results are listed in Table 7.2. The results indicate [illegible] Options 1 and 2 [illegible] operational [illegible] measures will be needed to maintain reliability prior to the new transmission lines being [illegible]. These operational mitigation measures may include [illegible] load shed.

Table 7.2 Steady State Voltage Stability Assessment of All Options for Culberson Loop Load Serving Capability with Reactive Devices Only

	Culberson Loop Load Served (MW)		
Description	Option 1	Option 2	Option 3
PV Voltage Collapse Results (reactive devices only)[1] (NERC P1 P6 P7 ERCOT Events)	801	821	1001
PV Voltage Collapse Results (without PBSES units) (reactive devices only)[1] (NERC P1 P6 P7 ERCOT Events)	721	741	880[2]

(1). Assuming reactive devices will be in service before new transmission lines

(2) Oncor indicated that the reactive devices identified to be located at Quarry Field 138 kV Switch Station may not be in service by summer 2019 ERCOT performed a PV analysis considering only the reactive devices located at Horseshoe Springs from Option 3 The results showed that without the Quarry Field reactive devices in service Option 3 would have a load serving capability of 721 MW

7 Economic Analysis

Although this RPG project is driven by reliability needs, ERCOT also conducted an economic analysis to identify any potential impact on system congestion related to the addition of the transmission upgrades.

The base case for this economic analysis used the 2023 economic case built in the 2017 RTP as the starting case. The topology changes and generation additions were similar to the steady state base case built. ERCOT modeled each of the three short-listed options and performed production cost simulations for the year 2023. The annual production analysis showed no measurable congestion impact on the ERCOT System with the addition of the transmission upgrades.

8. Subsynchronous Resonance (SSR) Vulnerability Assessment

According to Protocol Section 3.22.1.3(2), ERCOT performed a SSR vulnerability assessment using topology check and the results indicated that all the short-listed options strengthen the transmission network and increase the required transmission circuit outages to make a Generation Resource become radial to series capacitors. The SSR assessment results showed no SSR vulnerability for any existing Generation Resources or Generation Resources satisfying Planning Guide Section 6.9 conditions for inclusion in the planning models at the time of this study.

9. Final Options Comparison

As shown in Table 9.1, a comparison of study results for the three options shows that Option 3, shown in Figure 9.1, met the system reliability criteria under the studied load conditions while providing better load serving capability to accommodate both the near-term and potential future load needs in the Culberson Loop area

Table 9.1 Options Comparison

Description	Option 1	Option 2	Option 3
Capital cost ($ Million)	300.0	292.5	[illegible]
PV Results, Culberson Load Served	1608	1568	[illegible]
PV Results, Culberson Load Served (with only reactive support devices recommended in the options)	801	821	[illegible]
PV Results, Culberson Load Served (without PBSES Units)	1506	1468	1648
PV Results, Culberson Load Served (without PBSES Units) (with only reactive support devices recommended in the options)	721	741	[illegible]
Dynamic Stability Results, Culberson Load Served	Acceptable	Acceptable	Acceptable

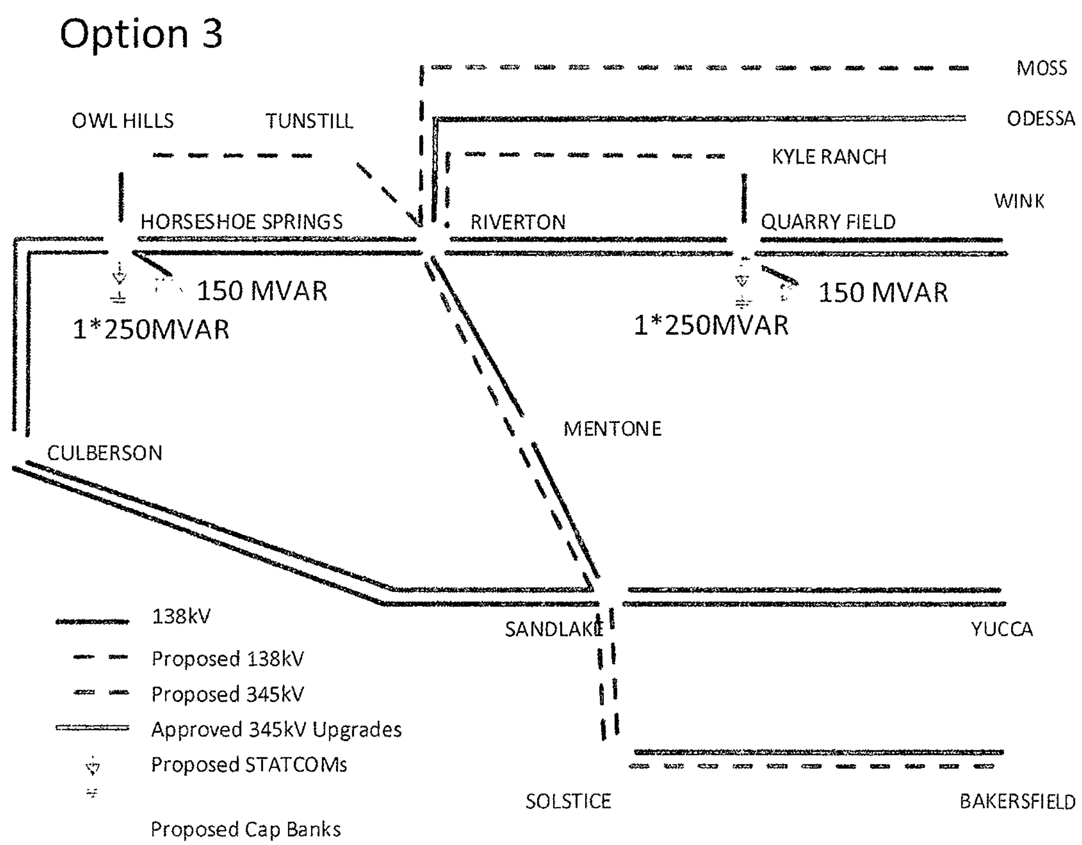


Figure 9.1 Option 3

10. Sensitivity Studies

Sensitivity studies were performed to ensure compliance with Planning Guide requirements

10.1. Generation Sensitivity Analysis

According to Planning Guide Section 3.1.3(4)(a), the generation sensitivity analysis will evaluate the effect that proposed Generation Resources in or near the study area will have on a recommended transmission project. Based on the 2018 April Generator Interconnection Status report, Table 10.1.1 shows all the generators in the area that met Planning Guide 6.9 and Table 10.1.2 shows all the generators in the area with a signed standard generator interconnection agreement (SGIA) that did not meet Planning Guide 6.9 conditions for inclusion in the planning models. Considering the oil and gas industry load characteristics the most stressed system condition is during the night when solar generation is not available. No solar generation in the Culberson Loop was assumed available in the study base conditions. Therefore, the proposed Generation Resources in the Culberson Loop area will have no impact on the recommended transmission project.

Table 10.1.1 Generators Met Planning Guide Section 6.9 Conditions (2017 March GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
14INR0044	West of Pecos Solar	100	Solar	Reeves	Far West

Table 10.1.2 Generators with SGIA That Did Not Meet Planning Guide Section 6.9 Conditions (2017 March GIS report)

GINR Number	Project Name	MW	Fuel	County	Weather Zone
18INR0022	Winkler Solar	150	Solar	Winkler	Far West

10.2. Load Scaling Impact Analysis

Planning Guide Section 3.1.3(4) (b) requires evaluation of the impact of various load scaling on the criteria violations seen in the study cases.

Because the voltage violations were observed at load serving busses inside the Culberson Loop, ERCOT assumed that the load scaling in the outside weather zones did not have a material impact on the observed need

11. Conclusion

Based on the forecasted loads and scenarios analyzed, ERCOT determined that there is a reliability need to improve the transmission system in Far West Texas. After consideration of the project alternatives, ERCOT concluded that the upgrades identified in Option 3 meet the reliability criteria in the most cost effective manner and provide needed load serving capability to the rapid oil and gas industry load growth in the Culberson Loop area. Option 3 is estimated to cost $327.5 million and is described as follows:

- Construct a new approximately 40-mile 345 kV line on double-circuit structures with one circuit in place from Sand Lake 345 kV Switch Station to Solstice 345 kV Switch Station
- Add two new 600 MVA 345/138 kV autotransformers at Sand Lake 345 kV Switch Station
- Install a new 345 kV circuit on the planned Riverton – Sand Lake double circuit structures
- Install the second 345 kV circuit on the Odessa EHV – Riverton 345 kV line double circuit structures between Moss and Riverton (creating a Moss – Riverton 345 kV circuit)
- Construct a new Quarry Field 138 kV Switch Station in the Wink – Riverton double-circuit 138 kV line
- Construct a new approximately 20-mile Kyle Ranch – Riverton 138 kV line on double-circuit structures with one circuit in place from Kyle Ranch 138 kV Substation to Riverton 138 kV Switch Station
- Construct a new approximately 20-mile Owl Hills – Tunstill – Riverton 138 kV line on double circuit structures with one circuit in place from Owl Hills 138 kV Switch Substation to Riverton 138 kV Switch Station
- Install the second 345 kV circuit on the planned Solstice 345 kV Switch Station – Bakersfield 345 kV Switch Station double circuit structures
- Install one 250 MVAR STATCOM at Horseshoe Springs 138 kV Switch Station
- Install one 250 MVAR STATCOM at Quarry Field 138 kV Switch Station
- Install 150 MVAR static capacitors at Horseshoe Springs 138 kV Switch Station
- Install 150 MVAR static capacitors at Quarry Field 138 kV Switch Station

The reactive support components, including STATCOMs and capacitors, recommended in Option 3 should be implemented by 2019 if feasible to accommodate the projected 250 MW Culberson Loop in summer 2019. Additionally, the sizing of capacitor bank stages should take into account operational considerations. Remedial operational schemes may be required to mitigate post-contingency voltage violations in the Culberson Loop area until the recommended transmission upgrades can be built to reliably serve the increasing load.

12. Designated Provider of Transmission Facilities

In accordance with the ERCOT Nodal Protocols Section 3.11.4.8, ERCOT staff is to designate transmission providers for projects reviewed in the RPG. The default providers will be those that own the end points of the new projects. These providers can agree to provide or delegate the new facilities or inform ERCOT if they do not elect to provide them. If different providers own the two ends of the recommended projects, ERCOT will designate them as co-providers and they can decide between themselves what parts of the recommended projects they will each provide.

Oncor owns the Odessa EHV Switch Station, Moss Switch Station and is planning to construct and own the new Riverton Switching Station and therefore is the presumed owner of the Riverton Switching Station. Therefore, ERCOT designates Oncor as the designated provider for the 345 kV Odessa EHV to Riverton and Moss to Riverton transmission facilities along with the two recommended 345/138 kV autotransformers at Riverton.

LCRA TSC owns the Bakersfield Switchyard while AEPSC is constructing and planning to own the new Solstice Substation and therefore is the presumed owner of the Solstice Substation. Therefore, ERCOT designates AEPSC and LCRA TSC as the designated co-providers for the 345 kV Bakersfield to Solstice transmission facilities but AEPSC as the provider of the two recommended 345/138 kV autotransformers at Solstice.

Oncor is planning to construct and own the new Sand Lake Switching Station and therefore is the presumed owner of the Sand Lake Switching Station, while AEPSC is constructing and planning to own the new Solstice Substation and therefore is the presumed owner of the Solstice Substation. ERCOT designates Oncor and AEPSC as the designated co-providers for the 345 kV Sand Lake to Solstice transmission facilities and Oncor as the provider of the two recommended 345/138 kV autotransformers at Sand Lake Switch Station.

Oncor owns all the 138 kV Switch Stations listed in the recommended Option 3. Therefore, ERCOT designates Oncor as the designated provider for all the 138 kV transmission facilities along with the proposed STATCOMs and static capacitor banks.

The designated TSPs have requested critical designation status for the Riverton – Sand Lake 345 kV Line, the Sand Lake – Solstice 345 kV Line, and the Bakersfield – Solstice 345 kV line for multiple operational and reliability needs to address the rapid load growth in the Culberson Loop area. ERCOT designates the project critical to reliability per PUCT Substantive Rule 25.101(b)(3)(D).

Appendix

Options Diagrams	Options_OneLine.pptx